The University of Texas at Austin

Undergraduate Research Journal

Volume 2 • Number 1
Spring 2003

The University of Texas at Austin Undergraduate Research Journal is a student edited and published multidisciplinary journal of undergraduate research.

Undergraduate Research Journal

THE UNIVERSITY OF TEXAS AT AUSTIN | 2003

Volume 2— Number 1— Spring 2003

The University of Texas at Austin Undergraduate Research Journal

Inquiries should be addressed to:

Senate of College Councils at The University of Texas at Austin
100-c West Dean Keaton Street
Suite 4.206
Austin, Texas 78712

Volume 2, Number 1

ISSN 1538-9421

The UT Undergraduate Research Journal is a part of the Senate of College Councils Research and Grants Committee. The Senate of College Councils is a registered student organization at the University of Texas at Austin and its views do not necessarily reflect the views of the university.

Printed in the United States of America
at Morgan Printing in Austin, Texas

THE UNIVERSITY
OF TEXAS AT AUSTIN
Undergraduate Research Journal

VOLUME 2 - SPRING 2003

VISIT US ONLINE AT:
http://www.utexas.edu/research/resources/urj

Subscriptions are $7.50 annually for 2003. All subscription requests should be addressed to Senate of College Councils, attn: **Undergraduate Research Journal, 100-C West Dean Keeton Street, Student Services Building 4.204, Austin, TX 78712.**

LAYOUT + DESIGN
BY PREM CHANDRASEKARAN

The editors of this journal wish to thank Dr. Juan M. Sanchez, Vice President for Research, Dr. James W. Vick, Vice President for Student Affairs, and Dr. Sheldon Ekland-Olson for their generous support and guidance.

They also thank George H. Mitchell and the University Co-op for their generous support.

They offer their appreciation as well to Ms. Beth Dishman and the Office for the Vice President for Research, Ms. Gail Spillar, Ms. Donna Bellinghausen, Ms. Susan Pruett, Ms. Christine Henke, Ms. Annie Elderbroom, Ms. Becky Carreon, Ms. Chiquitta Harris, Ms. Ari Barnhill-Brown, Ms. Terry Sherrell, Ms. Sarah Tierney, Mr. Jerry Sun, and the Senate of College Councils for helping to make the UT-Austin Undergraduate Research Journal possible.

FROM THE EDITORS

Welcome to the second volume of the University of Texas at Austin Undergraduate Research Journal. The idea for this multi-disciplinary journal was born as part of a discussion in the Senate of College Councils, the UT Academic Senate, Research and Grants Committee. The purpose of the committee is to find ways to expand interest and access to undergraduate research activity at UT. We immediately became enamored with the idea of an undergraduate research journal because of its ability to be a vehicle for increasing interest in undergraduate research as well as its ability to be a medium for communicating the outstanding work of undergraduate students at the university.

In this first issue, you will find research articles from many disciplines found across our diverse campus. Each article was researched by undergraduate students and written with the purpose of being accessible to the entire university community. We hope that through these articles, you and all the members of the UT community will gain a greater understanding and appreciation of undergraduate work.

If you would like to contribute to future issues of the University of Texas at Austin Undergraduate Research Journal, we invite you to submit an article for our next issue or to become a member of our staff. Please visit our website at www.utexas.edu/research/resources/urj for more information.

We hope that you enjoy the rich and diverse student written and researched articles from across this great university. We now invite you to explore the articles within these pages and to discover new ideas and insights into our world.

Sincerely,

Courtney Cleland and Ryan Deschner
Editors-In-Chief

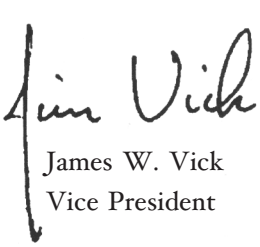
FROM THE VICE PRESIDENT AND PROVOST

Dear Colleagues: We are delighted to introduce the second student publication of undergraduate research at The University of Texas at Austin. This volume represents the broad range of scholarly work being done by our students and the excellent results being produced on our campus and in fieldwork throughout the world. The Senate of College Councils has provided a valuable service to our academic community by selecting some of the finest student efforts and publishing the work so that others may benefit from it.

In 1995 the Carnegie Foundation for the Advancement of Teaching created the National Commission on Educating Undergraduates in the Research University, often called the Boyer Commission after its initial presiding member, the late Ernest L. Boyer. Their landmark report proposes ten ways to change undergraduate education. Their first recommendation calls for strengthening student involvement in research, beginning at the earliest levels in the college experience. This publication is a clear indication that our University is moving with strong initiatives on this front.

On behalf of our faculty and administration, we congratulate the students who conducted the research reported here and the members of the Cabinet of College Councils whose hard work and dedication have brought this publication from an idea to a finished product. We look forward to expanding opportunities for undergraduate research and continued recognition of the students and their results.

Sincerely,



James W. Vick
Vice President

Sheldon Ekland-Olson
Provost

Contents

UNDERGRADUATE RESEARCH JOURNAL | 2003

Acceptable Sacrifice

Pollution at the Ashio Copper Mine

The University of Texas at Austin

Undergraduate Research Journal

Volume 2
Spring 2003

Kathryn G. Turner, *The University of Texas at Austin*

It seems perhaps inevitable in the human story that advancement must be accompanied by destruction. "Progress" has been defined by history in two opposing ways - both a prayer and a curse, a goal and a blight. It is the growth of technology, the innovation of new philosophies and governmental systems, and the adoption of new attitudes. But "progress" also means a plague on the environment and the destruction of communities. Tragically, this seems to be the case almost universally. A rise in factory production equals a decline in the health of every living thing within miles. What varies from event to event, however, is how the community, the society, and the government deal with the problem. In Japan, the pollution event centered around the Ashio Copper Mine (1890s) is one of the earliest and perhaps starkest example of progress walking hand in hand with destruction. Ashio, as a social, environmental, and

political problem, illustrates the relationship between the populace, business interests, and government specific to the Japan of its time. The actions taken by the victims and their supporters were, in fact, instrumental in altering those relationships, and redefining their position in the coming modern society.

Ashio Copper Mine is often touted as Japan's "first pollution incident" (Notehelfer, *Japan's*, 351), yet this is somewhat less than accurate. It is clear that pre-modern Japanese also had a negative impact on their environment. Ashio is not even the first incident of industrial pollution, for there is evidence of environmental damage from other mines in Japan which actually predates that of Ashio (Nimura, 21). What does mark Ashio as unique is that at this time and place, an opposition movement, powerful enough to alter central governmental policies, first emerged. Ashio is not the first incident of environmental damage in Japan, but rather the first incident of environmental protest. Ashio was in many ways the flag ship of the Japanese drive toward industrial modernization. Furukawa Ichibe, the brilliant entrepreneur who developed the mine, embodied the Meiji dream (Stone, 386). Yet his success lead to an ecological disaster in the area surrounding the mine.

Ashio Copper Mine lies in the town of Ashio in Kamitsuga county, Tochigi prefecture, central Japan, in the rough, mountainous country, across the Hoso-o Pass from Nikko. The complex is located at the headwaters of the Watarase River which passes through seventy miles of fertile farmland in four prefectures before joining the Tone River. The history of the mine dates back to the early 17th century, when copper was first mined along the banks of the Watarase (Notehelfer, *Japan's*, 352). Copper from Ashio graced the rooflines of the Tokugawa's vaunted Edo Castle and the mausoleum built for Ieyasu at Nikko. It was also the favorite export commodity in foreign trade with Holland and China during the 17th century (Ibid, 353). Initially one of Japan's most productive mines, excessive exploitation seriously depleted the mine's most accessible ore reserves and by the end of the Edo period, the site was all but abandoned (Stone, 386).

All of this changed however, when the mine came under the control of Furukawa Ichibe in 1877. Furukawa, born the second son of a bean curd merchant, rose to become one of the entrepreneurial geniuses of the Meiji period (Notehelfer, *Japan's*, 353), hailed as "a commoner who made good and created wealth and power not just for himself but for Japan" (Stone, 386). In his first year as owner, he increased the mine's yield by half, yet this was still insufficient to turn a profit (Notehelfer, *Japan's*, 354).

Furukawa faced many obstacles in his goal to modernize Ashio. When he gained ownership of the mine, it resembled a "beehive of holes in the ground" rather than a unified mine. Each pit was run by a sub-contractor who had almost complete autonomy. Within the mines there was little supervision – miners policed themselves through vigilante committees, often adopting the standard Tokugawa practice of removing a body part or beating to death as punishment. "Skimming," also a holdover from the Tokugawa period, was prevalent, and large amounts of copper were withheld by the miners and managers, and sold privately. Ashio also faced a severe shortage in labor, and Furukawa set forth a massive public-relations campaign to attract workers, staging elaborate publicity events and presenting new arrivals with personal gifts of *sake* (Notehelfer, *Between*, 20). In 1881, the mine was forced to appeal to the prefectural government for penal labor (Notehelfer, *Japan's*, 355). The quality of such labor was clearly demonstrated when five of the twenty criminals sent to work in the mine incapacitated their guard and escaped into the hills of Joshu. The mine was forced to hire eighteen "hunters" to trap the criminals, while for two days all penal labor was locked up and their furnaces left untended. The serious problem of transportation also plagued production at Ashio, and it is in this area that new technologies had the largest impact. At the time, almost all mine goods were transported on the backs of men, or at best in wheelbarrows, tying up a large percentage of the labor force.

In 1884, Furukawa's efforts paid off when a massive new vein, "best described as the Ashio mother lode," was discovered (Ibid, 356). By 1885, Ashio was producing ninety times more copper than in 1877. In 1888, Furukawa contracted with the French Copper Syndicate to produce large amounts of copper at a fixed price for twenty-nine

months, a good deal given the extreme fluctuations of the copper market (Ibid, 359). Yet Furukawa had contracted far in excess of his means. To meet his commitments, he would have to drastically increase production at Ashio. Furukawa began to pour large sums into the crash modernization of the mine, turning the small town of Ashio into one of the most technologically advanced centers in the country, rivaling Tokyo. Japan's first hydro-electric generating station was built at Matoo in the Ashio complex, and went into operation the summer of 1890, a full year before hydro-electric power came to the old capital of Kyoto (Ibid, 360), and only eight years after the first hydro-electric plant in the world went in to operation in the US (Stone, 386). In 1891, Ashio ran Japan's first electric railroad, largely solving the mine's transportation problems, four years before similar cars ran in Kyoto (Notehelfer, *Japan's*, 360). Electrification came to influence nearly all mine procedures. Furukawa also quickly adopted new copper refining methods, putting Ashio on the forefront of international copper production technology. These efforts pushed the mine's production to 165 times the amount in 1877 (Ibid), and made Ashio the largest copper mine and refining complex in Asia (Stone, 386). In 1891, upon completion of his contract with the French Copper Syndicate, Ashio produced approximately forty percent of the nation's copper. Given that, at the time, copper was Japan's third most important export commodity, behind silk and tea, it is apparent that the Furukawa Company and Ashio held a great significance for the Japanese economy in the 1890s.

Such massive leaps forward in industrialization carry with them heavy consequences. As early as 1880, there were signs that all was not well in the Watarase Valley. The mine's refinery produced noxious clouds containing sulfuric acid which withered surrounding forests (Nimura, 20) and hung in the air just beyond the town, a condition which still persisted one hundred years later (McKean, 36). The mine's waste water and runoff from slag heaps ran directly into the Watarase River. Residents in the area observed that the water of the Watarase turned "bluish white" and that dead fish came floating down the river, causing illness in those that ate them (Notehelfer, *Japan's*, 362). Later that year, the governor of Tochigi prefecture, fearing that that fish taken from the river would be hazardous to health, issued orders forbidding their sale. His concerns seemed to have earned him a quick transfer to another prefecture. Soon the Tone River was also affected, and by the late 1880s almost all marine life in both rivers was dead, plunging the more than 3,000 fishermen in the area into destitution.

The massive expansion of the mine in the 1880s resulted in the insatiable need for timber, in a country that had long ago begun to feel the pinch in lumber resources. Massive amounts of timber were required for the stabilization of mine shafts, as ties for the train system, and most importantly, as raw material from which to produce the tons and tons of charcoal needed in the smelting and refining processes. For cost and transportation reasons, most of this timber was taken from the hills around Ashio: "deforestation in the Ashio region became indiscriminate and massive in scope" (Ibid). In total, some forty square miles were logged to the ground (Stone, 387), effectively destroying the watershed.

With the watershed gone, flooding was inevitable. Without vegetation to hold the soil in place and absorb water, soil from the now barren mountains began silting up the bed of the Watarase. In 1890 the first major flood flowed out of the Watarase Valley and into the farmland, mostly rice fields, of Gumma and Tochigi Prefectures (Notehelfer, *Japan's*, 362). Unlike previous floods, which had deposited a rich new layer of silt in their wake, this flood did not result in a bountiful harvest. What made this flood and the many that followed it so disastrous was that it spread a thick residue of pollutants across the fields (Stone, 387). Nearly all vegetation touched by the flood waters, or planted in the affected land, shriveled up and died (Notehelfer, *Japan's*, 363). Men and women working in the fields soon developed sores on their hands and feet. Farmers near the river had to remove several feet of contaminated topsoil before they could grow anything at all (Stone, 387). "It was as if the hand of death had passed over the land" earning the Watarase the title of the River of Death (Notehelfer, *Japan's*, 363). Eventually, flooding and its after affects threatened the health and livelihood of people across six prefectures, twelve counties, and 136 towns (Nimura, 20).

Early in 1891, soil samples were taken from Aso Gun, one of the most seriously affected areas of Tochigi Prefecture (Notehelfer, *Japan's*, 363). Chemical analysis of these samples showed the soil to contain heavy concentrations of sulfuric acid, ammonia, aluminum oxide, magnesia, and iron, as well as smaller amounts of arsenious, nitric, and phosphoric acids, copper, and chlorine. The source of this pollution was clear to the scientist performing the analysis, and could only be Ashio Copper Mine.

With this evidence in hand, village leaders began the first round of protests in the established way. In the summer of 1891, a formal petition calling for the removal of the pollution and the temporary closure of Ashio Copper Mine was forwarded to the Minister of Agriculture and Commerce. The issue was brought before the Diet in December of that year, by Tanaka Shouzou, the highly vocal representative from the afflicted district in Tochigi Prefecture. Tanaka openly questioned the government's policy toward the afflicted farmers and the Ashio Copper Mine. In his strongly worded speech before the House of Representatives, Tanaka pointed out clauses in the Japanese Mining Law which called for the Minister of Agriculture and Commerce to shut down any "mining enterprises [which] are injurious to the public interest" (Ibid, 364). Tanaka called for proposal of plans for the relief of the afflicted farmers and fisherman and pre-emptive measures to prevent such a tragedy from reoccurring.

The government made its first public statement about the Ashio problem in the summer of 1892, nearly a year after the initial petition. The government declared that "while it was aware that the difficulties in Gumma and Tochigi were attributable to effluents from the Ashio Copper Mine, this pollution was not sufficient to be labeled 'injurious to the public interest'" and therefore did not warrant the closure of the Japan's most productive mine (Ibid). It further declared that local relief efforts were beyond its jurisdiction, and Furukawa Ichibe, the mine's owner, was taking steps to prevent further pollution.

Even had the government agreed to the closing down of Ashio Copper Mine, it would have had little immediate effect on the Watarase River. The pollution caused by Ashio was rather more complex. Even using the cutting edge technology of the time, copper extraction was still crude and inefficient. Sizeable amounts of raw copper compounds remained in the huge piles of tailings that littered the Ashio area (Ibid, 365). With every rainfall or flood, large quantities of water would wash these acidic copper compounds into the Watarase River. Water control was essential to solving the pollution problem, but that required reforestation. Reforestation was hampered by the smoke from Ashio's smelters, and would require a technological change. But Ashio and Furukawa were already using the latest technology available. Copper mining in the 1890s was ecologically damaging world-wide, but most Western mines had no pressure to develop cleaner methods because they happened to be located in sparsely populated areas that could support more pollution. When Furukawa agreed to undertake technological improvements in the area of pollution control, it was only in those aspects that increased production, that is to say to increase the efficiency of copper retrieval from low-quality ore, leaving less for the slag heaps (McKean, 36).

In the summer of 1892, Furukawa met with village leaders to discuss indemnity settlements (Ibid; Notehelfer, *Japan's*, 366). Furukawa promised to install ore-dust extraction equipment by June of 1893 and to pay a small sum as annual compensation for damages to villagers. In return the villagers agreed to abstain from any form of complaint about their circumstances until June 1896, when tests on the new equipment would be completed. The payments, however, usually went to landowners and village leaders, effectively buying their cooperation (McKean, 36). Furukawa found this situation quite satisfactory, and during the Sino-Japanese War (1894 – 1895) while dissenting voices were otherwise occupied, agents of the mine made the rounds of the villages and induced the local leaders to sign "permanent agreements" designed to perpetuate their silence on an indefinite basis (Notehelfer, *Japan's*, 367).

During these four years of silence, conditions in the Watarase Valley deteriorated further. By the mid-nineties even the hardy willow and bamboo groves along the

Watarase withered and died. Peasants observed that snow melted much more rapidly than usual. The region's previously plentiful insect life disappeared, causing a death-like silence to hang over the land. Birds totally disappeared. Even more disturbing, the pollution affects began to be apparent in the villagers themselves. Lactation failure among new mothers rose as did the infant mortality rate.

All of these things contributed to the mounting discontent in the peasantry. The return of the villagers who had served in the Sino-Japanese War brought a new sense of militancy to the region. In defiance of the Furukawa contracts, preparations for a massive protest began as their period of promised silence drew to a close (McKean, 37). Tanaka Shouzou resumed his spirited criticism of Furukawa and the government in the Diet. The government, for its part, was reluctant to make an issue out of Ashio, as it represented the development of heavy industry which they sought to promote (Notehelfer, *Japan's,* 369).

In September of 1896, following two months of record rainfall and several typhoons, the greatest flood for nearly forty years flowed out of the Watarase Valley and into the Kanto basin, extending the contaminated area to 24,000 hectares in six prefectures (McKean, 37). In Ashio alone, more than 300 lives were lost (Notehelfer, *Japan's*, 369). This confirmed the failure of Furukawa's pollution and flood control measures, and following the flood, a new petition was sent to the government, demanding that the mine be shut down, taxes reduced in the hardest hit areas, and repair of important infrastructure that had been damaged in the flood undertaken (McKean, 37). In a creative and ultimately largely successful tactic, Tanaka persuaded influential governmental officials to tour the affected area, resulting in the issuance of a directive to the Furukawa Company to institute unspecified "preventative construction" (Notehelfer, *Japan's*, 371).

As protests over the issue grew louder, and awareness and support came on a national level, a movement to arouse public opinion unlike any before was under way by the beginning of 1897. The movement brought together many diverse groups including Christians, socialists, activists (Ibid, 370), and especially a group of late Meiji Left journalists, which Alan Stone refers to as the Japanese Muckrakers (Stone, 397). The Muckrakers advanced the pollution victims' cause through popular journalism, averaging two articles a day in the *Mainichi Shinbun*, the main newspaper, for a six month period between 1901 and 1902. The Muckrakers and other actors in this movement utilized all the influence they had over individual members of the government. One such man, Kurihara Hikosaburou, readied himself for ritual suicide outside the front door of a government official's home in order to gain an interview (Ibid, 372).

But the farmers themselves were not idle. On March 23rd, 1897, a group of 800 farmers left their base of operations in a Zen temple in the affected region on a march to the capital (Notehelfer, *Japan's*, 374). In an unprecedented move, it was their plan to present their petition directly to the Imperial Household Ministry, thereby involving the Imperial House itself in the debate. The march itself resembled peasant uprisings from the Tokugawa period, and the police made every effort to halt the procession, going so far as to disassemble a major bridge across the Tone River. Only 80 farmers reached Tokyo, but they presented their petition to the Minister of Agriculture and Commerce.

Faced with such pressures, the government was finally prompted into action. Its response was not the closure of the mine, but the issuance of "the most Draconian anti-pollution order ever given to a major Japanese industry" (Stone, 393). Furukawa was ordered to construct elaborate facilities to reduce pollution - such as precipitation ponds, filtration pools, equipment to reduce the release of noxious gasses, and the relocation of the mountains of accumulated tailings to new, non-porous foundations (McKean, 37). Deadlines for completion of the work ranged from thirty to 150 days, with closure the consequence for not successfully fulfilling the tasks (Stone, 393). Furukawa leapt to comply with theorder, and succeeded in meeting the deadlines, spending about half the total value of the mine's annual production in the process.

However, this was not a perfect solution. Given the nature of the Ashio pollution situation, results were not immediately visible. Fertility did not return to the affect-

ed soil until after 1904 (Notehelfer, *Japan's*, 375). There was no fast way to restore the watershed, and floods continued to scour up old contaminants from the bottom of the Watarase (Stone, 394). The farmers protest movement grew more aggressive and the mass marches to Tokyo continued.

In a surprisingly sophisticated and politically savvy way, a "final" mass march was organized in February 1900. The march was populated by men who were "prepared to sacrifice themselves for the people of the area" (Notehelfer, *Japan's*, 376). The threat of violence ran throughout these plans, and arrangements were made to have physicians accompany the marchers, should they clash with police (Stone, 395). A conscious effort was made on behalf of the marchers to make it resemble a Tokugawa peasant uprising. Marchers wore conical straw hats, rain capes, and sandals, making them indistinguishable from a peasant of the earlier era, thereby enabling the march to evoke a pre-industrial time, when the ruling bodies were personally responsible for the health and welfare of their citizens. The morning of February 13th, 1900, somewhere between 2000 - 3000 marchers set out (Notehelfer, *Japan's*, 377; Stone, 395). By noon they had reached the village of Kawamata on the banks of the Tone River. There the marchers clashed with a police force of nearly 200 men (Stone, 395). By the time the incident was over, six policemen and fifty marchers were seriously injured, and 100 farmers were arrested.

The outcome of the Kawamata Affair, as it came to be called, was at first a setback for the pollution victims, as they were compelled to give up the militant tactics of the Tokugawa peasant uprising (Stone, 396). But after new tactics were adopted, the event became the key to the eventual success of the movement.

The case was first brought to trial in the District Court at Maebashi, where the court's attention was focused solely on the legalities of the case, and not at all on the motivation behind the event. The District Court found twenty-nine of the defendants guilty of resisting public officials, and the rest innocent. The case was then appealed to the Tokyo Court of Appeals, where it was handled quite differently. In the protracted nine month retrial that followed, thorough attention was paid to every aspect of the pollution problem, including extensive court-ordered examinations of conditions in the countryside. Indeed, the judge went so far as to take the entire court, including several members of the press, on a tour of the area for one week (Notehelfer, *Japan's*, 378). At the judge's request, the media was highly involved, and the cause was taken up by the Tokyo press, turning "Japan's last peasant rising" into one of its "first 'social problems'" (Stone, 396). Eventually, after every detail of the Ashio situation became widespread public knowledge, the case was thrown out on a curious technicality, and all charges dismissed (McKean, 37).

In an attempt to quell the issue – both political and environmental - once and for all, the government drafted a flood control project. The plan called for the purchase of Yanaka village, the heart of the protest movement, so that it could be turned into a reservoir (McKean, 38). Thus the most active protesters were compelled by the state to sell their land and disperse. Tanaka Shouzou protested this fiercely from 1903 to 1907, but never managed to attain the backing of the earlier movement (Notehelfer, *Japan's*, 380).

Furukawa's efforts did pay off eventually – serious flooding ceased and the amount of heavy metals present in the water dwindled to acceptable levels for the Meiji Japanese. Today, the Watarase River is again being used for drinking water and irrigation (Stone, 38). However, visible crop damage still occurs, and the levels of pollution which were acceptable during the Meiji period were much higher than today. In May 1974, 917 farmers accepted a settlement with Furukawa Company for damages suffered from 1952 to 1971. The mine closed in 1973, only because it had completely exhausted the copper supply.

One of the reasons that the Ashio cause was taken up so fervently by its supporters was because of what it signified. The Ashio problem embodied every fear and conflict faced by a nation plunging headlong into modernization: agriculture versus industrialism, the needs of the populace versus the needs of the nation, local authority versus national authority, the power of the court system versus the power of the ruling body. It made manifest the shaky transition between the social respon-

sibilities of the feudal Tokugawa government, and those of the new bureaucratic Meiji government. Ashio pitted big business against small farmer, and the health of the citizenry against the health of the economy. Similar difficulties have troubled Japan almost continuously since the 1890s. All the environmental movements to follow Ashio, including those that have yet to come, although unlikely to replicate the tactics, can hope to relive the success of this first incident of environmental protest.

Acknowledgments

I would like to thank Professor Robert O. Khan, my faculty supervisor, for offering the class which inspired this paper, Nature and the Environment in Pre-Modern Japan, a class perfectly suited to someone quirky enough to want to study Asian studies and plant biology. I would also like to thank Dr. Brett Westbrook for her enthusiastic encouragement and editing skills.

References

McKean, Margaret. *Environmental Protests and Citizen Politics in Japan.* "Participation through Environmental Litigation." Berkeley: University of California Press, 1981: 33 – 80.

Nimura, Kazuo. *The Ashio Riot of 1907: A Social History of Mining in Japan.* "Prologue: The Ashio Copper Mine and the Japanese Mining Industry." Durham: Duke University Press, 1997: 12 – 40.

Notehelfer, F. G. "Between Tradition and Modernity. Labor and the Ashio Copper Mine." *Monumenta Nipponica* Spring 1984 39 (1): 11 - 24.

Notehelfer, F. G. "Japan's First Pollution Incident." *Journal of Japanese Studies* 1975 1 (2): 351 – 383.

Stone, Alan. "The Japanese Muckrakers." *Journal of Japanese Studies* 1975 1 (2): 385 – 407.

Human Rights and U.S. Allies after September 11th

Two Case Studies: Uzbekistan and Tajikistan

The University of Texas at Austin

Undergraduate Research Journal

Volume 2
Spring 2003

Heidi Boutros, *The University of Texas at Austin*

When terrorists attacked the World Trade Center and the Pentagon, the stage was set for a dramatic shift in U.S. foreign policy. September 11th marked the beginning of a campaign to destroy terrorism around the world, a campaign which would be touted by governmental officials as an effort to protect human rights worldwide. However, many human rights activists worried that the U.S. would ignore the human rights record of countries that would be strategically important for the War on Terrorism. While the remarkable objectivity and accuracy of the State Department's human rights country reports suggests that the U.S. will not turn a blind eye to oppression occurring within our allies' boundaries, it appears that the government is not prepared to let its assessment of human rights conditions affect its foreign policy. One needs only to examine America's policy toward Uzbekistan and Tajikistan, two important

allies in central Asia, to understand the limited role human rights standards will play in shaping U.S. relations abroad.

The rhetoric of the War on Terrorism has placed global freedom, human rights, and democracy at the forefront of U.S. foreign policy. In Bush's speech to the nation on September 20th, he explained that terrorists have "called America to defend [her] freedom," but more than that, they have called the entire world to fight for liberty. The President asserted that this is not just America's war; it is "the world's fight ... the fight of all who believe in progress and pluralism, tolerance and freedom."[1] Lorne Craner, the Assistant Secretary of State for Democracy, Human Rights and Labor, echoed Bush's words when he stated that the War on Terrorism is being "fought not only to protect [American] rights and freedoms, but also to promote them throughout the globe."[2] With liberty at the heart of America's new war, the State Department has pledged to continue to withhold U.S. aid from countries with consistently egregious human rights records. The Bureau of Democracy, Human Rights, and Labor promised long ago that "human rights considerations [would be] incorporated into U.S. military training and security assistance programs."[3] Secretary of State Colin Powell said the American public could expect to see this policy persist, noting that while the U.S. will gladly accept the help of any nation that wishes to eliminate terrorism, it "will not relax [its] commitment to advancing the cause of human rights and democracy."[4]

Upon examination of the State Department's human rights report for Uzbekistan, an important U.S. ally with deplorable human rights conditions, it seems that America did not tone down its criticism of the country as some feared it would. The report described Uzbekistan as "an authoritarian state" whose "human rights record remained very poor," and it censured the Uzbek government for "[committing] numerous serious abuses."[5] Consistent with the Soviet tradition, Uzbekistan still "does not permit the existence of opposition parties"[6] or "independent news media."[7] The current president, Islam Karimov, became the country's leader in an election "that most observers considered neither free nor fair."[8] Human Rights Watch added that "the only alternative candidate in the 2000 presidential elections announced publicly that he voted for President Karimov."[9]

In addition to condemning the unfair elections, the State Department's report denounced Uzbek law enforcement officials for the torture, unjust imprisonment, and in some cases, murder of Muslims. For instance, the report cites that Ravshon Haitov was arrested, tortured, and killed last year for his suspected involvement in an Islamic organization called Hizb ut-Tahrir; although his body offered clear evidence of abuse, Uzbek officials claimed Ravshon died of a heart attack.[10] His brother, Rasul Haitov, was also imprisoned and beaten until "he became an invalid."[11] The Haitov brothers are only two of an estimated 7,000 to 7,500 Muslims who have been persecuted this year in Uzbekistan for the peaceful practice of Islam.[12] While Bush made it clear that the War on Terrorism is not a war on "our many Muslim friends,"[13] the Uzbeks have wrongly associated many practicing Muslims with Osama bin Laden as justification for imprisonment and torture. Given the Uzbek government's willful confusion of Islam and terrorism and its failure to improve its horrific human rights conditions,[14] one would expect the U.S. government to impose sanctions on Uzbekistan, thereby placing pressure on the country to make progress with regards to the current human rights conditions.

Despite U.S. assurances that "[respecting] human rights and [embracing] democracy" are necessary preconditions for positive relations with the States,[15] America has chosen not to impose sanctions but rather to align with Uzbekistan in the war against terrorism. Even though the country's dismal human rights record is not improving, the U.S. seems prepared to look beyond Uzbekistan's severe disrespect for liberty because of the strategic importance of the country in American's new war on terrorism. Uzbekistan is not only advantageous because of its geographic location[16] but also because numerous well-equipped military bases remain from its unsuccessful battle against Afghanistan in the 1980s.

While Uzbekistan may not get "reduced criticism about [its] treatment of the domestic Islamic fundamentalist resistance"[17] or "an end to criticism about its human rights record"[18] as it had hoped, the U.S. is offering

something more valuable: military and economic aid. Soon after the terrorist attacks on America, the U.S. government announced that it would supply Uzbekistan with $100 million in aid.[19] This funding is dedicated largely toward military training, security measures,[20] and civil society building.[21] Although the State Department "[certified] that improving human rights conditions are a precondition to continued American financial aid,"[22] in reality, this rule does not apply to countries that are strategic bases in the U.S. War on Terrorism. In fact, the U.S. has failed to even "condition such aid on improvements in local human rights."[23] While Washington is painfully aware of Uzbekistan's egregious human rights record, it is not prepared to allow its knowledge to have unfavorable policy implications. That is, the U.S. government is unwilling to limit military assistance or impose sanctions on Uzbekistan for fear that doing so could potentially result in the loss of this nation's support in the War on Terrorism.[24]

U.S. policy toward Uzbekistan is not an isolated example of America allowing its interest in the War on Terrorism to override its policy of limiting U.S. aid to countries with consistently substandard human rights conditions. In fact, U.S. relations with Tajikistan, another former Soviet Republic with a deplorable human rights record, have closely mirrored U.S. relations with Uzbekistan.

The State Department offered a remarkably objective and accurate description of the abundance of human rights abuses occurring in Tajikistan, just as it did with Uzbekistan. Overall, the state of human rights in Tajikistan was judged to be "poor," and the State Department found the Tajik government to be responsible for "serious abuses."[25] Among the key problems mentioned were extrajudicial killings, poor prison conditions, police misconduct, extremely limited freedom of speech and freedom of the press, and trafficking in persons. The report repeatedly draws distinctions between how Tajikistan ought to be according to its laws and constitution and how it is in reality. While the Constitution calls for freedom of speech and freedom of the press, "the government severely restricts [these rights] in practice."[26] While the Constitution calls for the right to privacy, "authorities continued to infringe on citizens' right to privacy."[27] While "the law prohibits torture ... the government uses it in practice."[28] While the Constitution stipulates freedom of peaceful assembly and freedom of association, "the government restricts [these rights] in practice by exercising strict control over organizations and activities of a political nature."[29] While the Constitution provides for "the right of citizens to change their government peacefully and freely through elections," elections tend to be one-sided and unfair.[30] While the law provides for equality between men and women, "discrimination against women remained a problem."[31] All of these assertions are confirmed in Human Rights Watch's 2001 report on Tajikistan.[32] Although the Constitution and laws of Tajikistan tend to be consistent with international human rights standards, it is clear that enforcement of these documents is lacking.

Like Uzbekistan, Tajikistan has often persecuted people for the peaceful practice of Islam. According to the State Department human rights report, "government policies reflect a pervasive fear of Islamic fundamentalism."[33] For instance, Tajik officials outlawed all activities of Hizb ut-Tahrir, an Islamic group that peacefully advocates for Muslim control of government. Although the arrest, imprisonment, and torture of Muslims is not as frequent or severe in Tajikistan as in Uzbekistan, these injustices are still prevalent. In 2001, the Tajik Ministry of Security reported the arrest of "more than 105 members of Hizb ut-Tahrir,"[34] and at least one member of the organization "died in police custody."[35] By aligning itself Tajikistan and Uzbekistan, two countries who are consistently oppressing Muslims, the United States is coming dangerously close to fighting a war against Islam as opposed to a war against terrorism.

Given the United States' insistence that the war on terrorism is not a war against Islam, one might have expected these U.S. alliances to be conditioned upon improved treatment of Muslims, if not upon increased respect for human life and dignity in general; however, in its eagerness to gain advantages in the battle against al Qaeda, America has chosen to ignore the egregious human rights abuses of its allies. Shortly after September 11th, U.S. Secretary of Defense Donald Rumsfeld traveled to Tajikistan,

a country that shares a 750-mile border with Afghanistan, to request that it join the coalition against terrorism and to examine its potential as a base for U.S. forces. After a discussion between Rumsfeld and Tajik Foreign Minister Talbak Nazarov, Tajikistan agreed to allow the United States to use its airspace for "humanitarian and search-and-rescue missions" with the possibility of extending U.S. privileges "to include military flights."[36] At the conclusion of his visit, Rumsfeld announced that Tajikistan support was "very real and very important from the standpoint of over-flights, intelligence gathering, and various types of military-to-military cooperation."[37]

In fact, Tajikistan's assistance was so important that on January 9, 2002, the U.S. lifted a ban on arms sales to Tajikistan that had been in place since 1993. The U.S. Defense Secretary, when questioned about the removal of restrictions on the transfer of military equipment to Tajikistan, underplayed its importance, saying that "from time to time, countries are added and deleted from this list, in accordance with ... our outlook on things."[38] The reason for the change, according to Rumsfeld, is Tajikistan's willingness to cooperate with the U.S. in its war against terrorism in addition to "other changes in [U.S.-Tajik] relations."[39] Rumsfeld told journalists that he could not comment on any specific transactions between the United States and Tajikistan, adding that transactions would be considered "on a case-by-case basis."[40] When a reporter asked, "Change of subject?" Rumsfeld welcomed the shift in subject matter, saying, "Please." The Defense Secretary's eagerness to change the subject in addition to his vague responses and his implication that removing countries' restrictions is routine may suggest that Rumsfeld feared criticism regarding the U.S. decision to supply military aid to Tajikistan. Clearly, the Achilles' heel of the United States post September 11th policy toward Tajikistan is America's dramatically increased military aid without consideration of the Tajik human rights record.

Since September 11th, the War on Terrorism has dominated U.S. foreign policy to the extent that human rights considerations no longer factor into U.S. policymaking. U.S. governmental officials have decided that the American mission to eradicate terrorism is best served when the United States supplies economic and military aid to countries that commit to join the international coalition against terrorism. This decision has compromised U.S. commitments to adjust its foreign policy in accordance with human rights conditions abroad. There is no shortage of evidence to attest to the truth of this compromise. It can be seen in American relations with Azerbaijan, India, Pakistan, Yugoslavia, China, Russia – nearly every nation in Asia. The terrorist attacks in New York and Washington, D.C. have marked the beginning of a dangerous era in which American ethics are being sacrificed in favor of American interest.

Endnotes

1 President Bush's speech on September 20, 2001. http://www.whitehouse.gov/news/releases/2001/09/20010920-8.html

2 From the transcript of the news briefing in which Secretary of State Colin Powell and Assistant Secretary of State for Democracy, Human Rights, and Labor announce the release of the 2001 Country Reports for Human Rights Practices. http://usinfo.state.gov/cgi-bin/washfile/display.pl?p=/products/washfile/topic/rights&f=02030501.ddh&t=/products/washfile/newsitem.shtml

3 State Department's Bureau of Democracy, Human Rights, and Labor website. http://www.state.gov/g/drl/hr

4 From the transcript of the news briefing in which Secretary of State Colin Powell and Assistant Secretary of State for Democracy, Human Rights, and Labor announce the release of the 2001 Country Reports for Human Rights Practices. http://usinfo.state.gov/cgi-bin/washfile/display.pl?p=/products/washfile/topic/rights&f=02030501.ddh&t=/products/washfile/newsitem.shtml

5 State Department Country Report on Human Rights Practices for Uzbekistan. http://www.state.gov/g/drl/rls/hrrpt/2001/eur/8366.htm

6 Id.

7 Human Rights Watch, "Uzbekistan: U.S. Cautioned on New Ally" http://www.hrw.org/press/2001/10/uzbek1004.htm

8 State Department Country Report on Human Rights Practices for Uzbekistan. http://www.state.gov/g/drl/rls/hrrpt/2001/eur/8366.htm

9 Human Rights Watch, "Repressive Uzbek Leader to Visit White House" http://hrw.org/press/2002/03/karimov0703.htm

10 State Department Country Report on Human Rights Practices for Uzbekistan. http://www.state.gov/g/drl/rls/hrrpt/2001/eur/8366.htm

11 Id.

12 Id. and *The Washington Post*, October 5, 2001. "A Word of Caution on a New Asian Ally" http://www.hrw.org/editorials/2001/afghan-1005.htm

13 President Bush's speech on September 20, 2001. http://www.whitehouse.gov/news/releases/2001/09/20010920-8.html

14 The State Department Country Report on Human Rights Practices for Uzbekistan states more than once that "progress has been very limited." http://www.state.gov/g/drl/rls/hrrpt/2001/eur/8366.htm

15 Lorne Craner, assistant secretary of state for democracy, human rights, and labor. http://www.eurasianet.org/departments/rights/articles/eav030602.shtml

16 Uzbekistan shares a border with Afghanistan.

17 CBC News Online, *U.S. Striking Back FAQ*, October 2001. http://www.cbc.ca/news/indepth/us_strikingback/backgrounders/faqs_usdeals.html

18 The Associated Press, "Uzbekistan to Receive $100 Million in U.S. Aid for Help in War" http://www.khilafah.com/home/category.php?DocumentID=3073&TagID=2

19 Id.

20 Human Rights Watch, "U.S. Military Aid after 9/11 Threatens Human Rights" http://www.hrw.org/press/2002/02/usmil0215.htm

21 Human Rights Watch, "Repressive Uzbek Leader to Visit White House" http://hrw.org/press/2002/03/karimov0703.htm

22 The Economist, March 5, 2002. "Human Rights and Government Wrongs" http://www.economist.com/agenda/displayStory.cfm?Story_ID=1010518

23 Human Rights Watch, "U.S. Military Aid after 9/11 Threatens Human Rights" http://www.hrw.org/press/2002/02/usmil0215.htm

Heidi Boutros

24 Despite the scathing criticism of Uzbekistan's treatment of Muslims in the 2001 State Department human rights report, the U.S. Commission on International Religious Freedom chose not to recommend Uzbekistan as a "country of particular concern" for religious freedom. According to the International Religious Freedom Act of 1998, the U.S. ought to respond to countries "of particular concern" with sanctions or limits on U.S. aid. Perhaps the United States decided against recommending Uzbekistan because it anticipated that it would need that nation's help in its battle against the Afghan government.

25 State Department Country Report on Human Rights Practices for Tajikistan. http://www.state.gov/g/drl/rls/hrrpt/2001/eur/8353.htm

26 Id.

27 Id.

28 Id.

29 Id.

30 Id.

31 Id.

32 Human Rights Watch, October 5, 2001. "Human Rights Watch Press Backgrounder on Tajikistan" http://www.hrw.org/backgrounder/eca/tajikbkg1005.htm

33 State Department Country Report on Human Rights Practices for Tajikistan. http://www.state.gov/g/drl/rls/hrrpt/2001/eur/8353.htm

34 Id.

35 Id.

36 Eurasianet.org, November 5, 2002. "U.S. Eyes Bases in Tajikistan" http://www.eurasianet.org/departments/insight/articles/eav110501a.shtml

37 Id.

38 State Department Noon Briefing by Richard Boucher on January 9, 2002. http://www.usembassy-israel.org.il/publish/peace/archives/2002/january/011002.html

39 Id.

40 Id.

Madres de Plaza de Mayo

An Argentine Nongovernmental Organization

The University of Texas at Austin

Undergraduate Research Journal

Volume 2
Spring 2003

Edgar A. Morales, *The University of Texas at Austin*

The presence of nongovernmental organizations (NGOs) around the world has increased in the last hundred years. Among them, the presence of human rights-specific nongovernmental organizations has also increased.[1] As these groups continue to organize into local, national and international entities, their collective resources increase the likelihood that their agenda are heard not only by world governments, but also by the people of those states. Although human rights-specific NGOs are not solely responsible for creating human rights awareness—in fact, the case may be that the interest in human rights spawned these NGOs into existence—NGOs play important roles in promoting humanitarian values. Among the thousands of NGOs now active for diverse interests, the Argentine nongovernmental organization, Madres de Plaza de Mayo, has been successful in its attempts to create awareness of human

rights violations by their government during the military rule of 1976-1983. In comparison to other human rights-oriented NGOs, the Madres' reasons for grouping together, constituency their organization and the methods through which they achieved their goals differed greatly from that of better known, mainstream NGOs, such as Amnesty International and Human Rights Watch.[2] However, studying the Madres from the NGO perspective is not wholly inadequate, since the means to their end are reminiscent of the manner in which mainstream human rights NGOs comport themselves.

The purpose of this study is to identify how the Madres differ from other nongovernmental organizations in the area of human rights. I will also attempt to address the historical circumstances under which the Madres formed and why the military allowed them to exist. Finally, this report will study the methods through which human rights-oriented NGOs create pressure on governments to change their behavior with respect to human rights violations: directly through publications and petitions addressed to abusive governments, and indirectly through their influence on IGOs and countries which may be in position to sanction a state. To facilitate the study of NGOs in the area of human rights, it is helpful to attempt to define what NGOs are: NGOs are private organizations of individuals, entirely or largely independent of government and have primarily collaborative or humanitarian, rather than commercial objectives. Examples of NGOs' interests include support for international development, indigenous groups, the environment, human rights, academic freedom, science, recreation, religion, etc. NGOs may exist in the form of interest groups, religious movements, terrorist organizations, ethno-political movements, multi-national corporations, etc.

About the Madres de Plaza de Mayo

The period in Argentine history called "La Guerra Sucia," or the "dirty war" began when the military took control of the government in 1976. With great speed, the military began to "disappear," or abduct and kill, political dissidents, including intellectuals, academics, lawyers, students, leaders of labor organizations, etc. Accounts of abductions have been articulated in various sources[3], though most note that during the night or in the hours before dawn, unmarked Ford Falcons would surround a house and enter into it by force.[4] The abductions prompted the families of the disappeared to search for them, sometimes believing that their incarceration was a simple misunderstanding.[5] When the families found no answer or the government would not cooperate, they had no choice but to keep asking others about their whereabouts or looking for them on the streets.

The estimated number of missing persons has been placed at 30,000, though the government has disputed this figure. When families looking for their missing petition the same government office and continue to run into each other, their individual problems begin to become a common malady and the pattern of repression becomes evident. It is important to mention here that there is no such thing as the Padres de Plaza de Mayo. The fact that the Madres' organization was founded and operated by women, the mothers of the disappeared, is a result of the division of labor between the sexes in Argentine society. Although fathers, brothers, friends and other people participated with the Madres in various ways, the bulk of the constituency was made up of women. Traditionally, women have been in Argentina confined to the domestic sphere as homemakers or were only represented in the work force in areas of education, service, and manual work.[6] While the men went to work, the mothers of the disappeared focused their energy and frustration into an organization whose purpose was to find their offspring.[7] At first, the Madres organized themselves by meeting a few at a time in churches or at the homes of other mothers. On April 30, 1977, fourteen mothers assembled in the Plaza de Mayo, where the major institutions of Argentine government are located. Since then, their protests have continued until now and their agenda has expanded somewhat, but their group still demands to know the whereabouts of the disappeared.

How NGOs Achieve Their Goals

Most nongovernmental organizations exist because

the people that make up that body feel a need for such an organization to address a concern. NGOs utilize advances in technology that make it possible to communicate to a wide audience by using the media as a forum on which to announce their goals and ideology. Widespread accessibility to television, radio and more recently, the internet, allows NGOs to export images of their actions and ideology to a worldwide audience. Amnesty International and Human Rights Watch, both of which are mainstream human rights NGOs, employ communications systems in an attempt to "shame" governments by exposing their human rights violations to a global audience. It is hoped that audiences will be outraged and will take some action to change the situation. The expected levels of audience participation among civilians may vary. For example, they may choose to write a letter to the offending government, choose to protest their governments' policy towards a specific country, organize relief efforts in their own community, and so on. Another target of NGO exposés are foreign governments themselves. Foreign governments may be criticized for not acting against the human rights violations in a country or for continuing foreign aid allocations.

Though the degree of NGO participation in world affairs may vary historically[8], patterns of involvement and collaboration with government and other groups are evident in the development of NGOs. Along with NGO collaboration at different levels of "policy production," the individuals (intellectuals, professionals and activists) participating with NGOs have become increasingly specialized. That is, they are prominent members of the legal elite—leaders of the legal profession, former members of the judiciary and prominent legal academics.[9] It is most probable that people who direct or found NGOs are themselves knowledgeable about organizing resources and managing the organization, but as NGOs become more focused the necessity for the incorporation of high-skilled individuals increases—resulting in a system of positive feedback, a reprioritization of NGO interests and a shift in the level of involvement in policy production. Another possible factor affecting the shift in orientation might be the increased involvement of scientific and professional organizations/individuals in defending human rights, such as the World Psychiatric Association or Mental Disability Rights International. The increase in attention of professional organizations is not limited to psychiatric organizations but is as wide-ranging as the interests that exist. The argument is that when professional organizations begin to involve themselves in human rights or address human rights violations, they lend credence and authority to claims made by human rights NGOs that may not have the same professional status.

The Madres de Plaza de Mayo as a Non Governmental Organization

The Madres de Plaza de Mayo can be studied from various perspectives, for example, the new social movement, the feminist movement, the human rights movement or the NGO movement, among various others. As an organization, the Madres did engage in "NGO-type" behavior, though certain aspects set them apart from mainstream human rights nongovernmental organizations. The purpose of this next section is to delineate where it is that the Madres seem to qualify as NGOs and where it is that they fail.

It is important to note that when the Madres first formed, there was no internet. They were not a stable entity with offices and communication equipment, able to openly encourage monetary donations. While large human rights NGOs like Amnesty International insist on drawing the bulk of their funds from private sources to appear impartial in their convictions, the Madres could not count on a large base of support from the Argentine population or the world public. Unlike Amnesty International, which was founded after Peter Benenson, AI's founder, wrote an article in *The Observer* (a British newspaper) titled "The Forgotten Prisoners"[10] which called for the creation of what would become AI, the Madres could not write an article in an Argentine paper demanding government accountability or calling for the formation of their own organization because newspaper content was monitored in the closed society that prevailed at the time. Further, the Argentine people could not or would not participate with the Madres' protests for fear of military retaliation and the world would not know

about their struggle via media coverage until much later—in fact, many people outside of Argentina who knew about the Madres in the early years of La Guerra Sucia were those that were informed of the movement by immigrants/refugees.

While groups like Amnesty International and Human Rights Watch concentrate their secretariats in relatively stable Global North states and often criticize offending governments from a physical distance, the Madres did not enjoy a politically stable or open atmosphere.[11] In fact, the military regime in Argentina during 1976-1983 has gone down in history as being extremely violent and repressive. Whereas other human rights NGOs can lobby for attention and funds in a society encouraging the freedom to assemble, the Madres struggled with the Argentine population's fear of being associated with them. In this respect, the Madres could not rally the public openly to their cause. While mainstream NGOs can grow at their own pace and as much as their resources allow, the Madres could not instantly or freely lobby for financial backing. In these areas, they differed from mainstream NGOs.

Furthermore, remaining skilled individuals who could have been helpful to the Madres in maneuvering around the bureaucratic obstacles imposed by the military regime (by helping them write a writ of habeas corpus, for example) were unwilling to cooperate with them for fear or being disappeared themselves.[12] In fact, the Madres suffered from a lack of manifest public support, in terms of marches at least, and Hebe de Bonafini, President of the Madres, recalls in a speech:

> "You well remember that in this era we were disliked, our families were perceived to be composed of "terrorists." They closed the doors on us and it was very few people with which one could converse. But with the Madres, we were all alike, the same things happened to us and we saw the same people."[13]

To further alienate the Madres, the Argentine military labeled the Madres as "*Las Locas*," or the "crazy ones." The intended effect was to discourage opponents of the regime or sympathizers to join the Madres simply because the government opposed them, but more generally, to discredit them and their claims. Even fellow mothers of the disappeared ended their relation with the group and family members also kept their distance from *las locas*.[14] Furthermore, the government constantly defended themselves by saying that the disappeared were Communists and that if their families no longer knew where they were, then it was likely that they had gone underground and joined an insurgent group.[15] The Madres, in contrast to other human rights NGOs, lacked free and open access to skilled individuals (sometimes those very individuals that were being disappeared), which were earlier identified as major agents in the development of policy and management of NGOs. The Madres themselves did not have too many skills since they were restricted to their homes and usually denied higher education. In this respect, they differed from mainstream human rights NGOs because they lacked access to skilled individuals and were themselves largely unskilled.

However, the Madres did show some signs of functioning as a human rights NGO. For example, since the media were hesitant to report on their activities, the Madres could still employ the power of information to bring about awareness of the disappeared. The Madres began to write their own newspaper and created chapters of their group in different parts of the country as they went on speaking tours.[16] They also contacted foreign leaders such as the sympathetic Italian president, Sandro Pertini, Pope John Paul II, journalists and other NGOs for support, creating an international presence for themselves.[17] It is clear that NGOs seek to expand their organizations by creating chapters and allying themselves with international figures, since this ensures a wider support base and consequently, a larger pool from which to draw financial and moral support. Also, it is beneficial for NGOs to seek out allies in the international arena who can vouch for their cause/worth and who can sanction the offending state directly or indirectly. The importance of symbols in the Madres' movement also became evident early on. Many different types of propaganda rely on symbols to appeal to their audiences and NGOs are no

exception. Amnesty International employs the use of a flame in barbed wire to symbolize their hope that "prisoners of conscience" will be freed. Amnesty and Human Rights Watch also post photographs of the prisoners they are attempting to help with text outlining the circumstances of their incarceration and the number of children they have. All of this information, while useful for the assessment of the prisoners' situation, is instrumental in instilling in the average citizen a sense of duty and outrage. Likewise, the Madres' use of symbols is instrumental in eliciting from people a sense of pathos, and consequently (and hopefully), a sense of duty which will prompt action from the public. Among the symbols used by the Madres are the ever-present *panuelo* (or head scarf), cardboard cutouts of human figures, pictures of their children, the Plaza de Mayo itself, etc. The first head scarf was made out of a diaper in order to establish a link from the mother to the child and was also worn to underscore the common use of head scarves by women who attended church. The scarves not only helped to identify the mothers with the movement, but also manipulated the collective unconscious to their advantage.[18] Pictures and white cardboard cutouts were meant to symbolize their missing children and the Madres staged huge marches with these props. Finally, the Plaza itself was a symbolic location where large gatherings by the founders of the Argentine state and protests by labor were held.[19]

It is clear that the Madres lacked many of the advantages typical human rights NGOs enjoy. The Madres are a type of aberrant NGO in this sense, since they did not form in a free society and they did not enjoy public support. Arguably, the Madres existed under extremely disadvantageous circumstances and it is interesting that they were not disappeared outright by the government. Other groups such as parties or individuals perceived to be a threat to the military were dealt with rapidly. The Madres on the other hand, were allowed to exist, even if the military harassed them. Some accounts note that plainclothesmen followed the Madres and even hired an informer to penetrate the Madres.[20] In addition to that type of harassment, at their marches, the Madres were charged at by police on horseback and one was even sequestered and disappeared.[21]

In retrospect, it is unlikely that men could have done what the Madres did—that is, protest against the government in such a blatant way by marching in an open city square where the institutions of government are clustered. If men had been the constituents of such an organization, it is probable that they would not have been allowed to demonstrate as the Madres did. In fact, for the Madres to have demonstrated was a shock in Argentine society, since women were perceived to be violating accepted norms of femininity, maternity and elderliness.[22] It is true that the Madres gained the respect of some for what they were doing, though it is also true that even their most mild critics attacked them not for their cause, but for the actions they took themselves. For example, one source records that the Madres were criticized for having "deserted their homes," and one individual affirmed that, "La virgen Maria jamas hubiera actuado de ese modo."[23] It is interesting to note that the Madres used the norms of Argentine society to survive—for example, when they were accosted by the police during their marches, they would offer no resistance, but simply began to pray aloud, reciting the Our Father and Hail Mary.[24] In this respect, we can understand that the Madres fail to qualify as a mainstream NGO, since their members are disproportionately of one sex and one age group, elderly females, and most human rights NGOs favor universal membership to avoid seeming biased.

As mentioned before, the Madres, much like mainstream NGOs, appealed directly to members of the international community. These appeals were of course made in the assumption that the international audience would care enough about their situation to act on their behalf. Individuals, states and intergovernmental organizations could all have chosen to criticize the military regime in an attempt to stop the repression. The Madres appealed to all three, but to assess the impact that outside influences had on dismantling the military regime is beyond the scope of this paper. It is sufficient to consider that the Madres placed enough value on the power of outside forces to appeal to them.

The Madres appealed several times to the world audience. For example, they embarked on speaking tours all over the world and used the 1978 World Cup soccer

matches held in Argentina, which attracted worldwide attention, to talk to journalists and tell their story. Another time, the Madres appealed to doctors attending the International Conference on Cancer Research in Buenos Aires, an event attracting attention from many people outside Argentina, and two of them marched alongside the mothers.[25] Moreover, the Madres visited with their supporters which included Italian President Sandro Pertini. The Madres also appealed to the Pope, who ignored them at first, but later met with them.[26] The Swedish government became one of the Madres' strongest supporters after inquires regarding a disappeared Swedish national resulted in the deterioration of the two countries' relations.[27] Over time, the Madres "gained admittance to the halls of the OAS (Organization of American States) and the United Nations, meeting with ambassadors and members of the Working Groups on Disappearances."[28] They have also submitted statements at human rights conferences as observers and evidently maintain their presence at these congregations.[29] In this method of operation, the Madres are very much a typical human rights nongovernmental organization, as they appeal to a world audience in the hope that others will help them in their struggle.

Finally, an important component of any group is that of ideology. Ideology can vary in importance to the maintenance and survival of any group's following. For example, some groups may base their appeal disproportionately on ideology and others may not. Most human rights NGOs adopt the Universal Declaration of Human Rights of 1948 as a base for their own ideology. Amnesty Internationals as well as the Madres adopted this text as a core document from which to elaborate their specific beliefs. For Amnesty, freedom of association and inalienable rights became prominent, though their ideology is not based on any notions of religious rights or family values directly; instead it focuses on the inherent and natural rights all humans possess. In contrast, the Madres' ideology (while accepting as a base the Universal Declaration of Human Rights) is influenced heavily their "radical interpretation of Christianity on the one hand...and the adoption of an anarchist position that true change could only come from the spontaneous linking of grass-roots efforts."[30] When asked which historical characters she admired most, Hebe de Bonafini, the President of the Madres, answered that she admired Mariano Moreno (Argentine revolutionary and publicist who was a leader in the revolution of May, 1810, which deposed the Spanish viceroy), Salvador Allende, Augusto Sandino, Che Guevara, and Eva Peron[31] who some consider to have begun the movement to incorporate women in Argentine politics.[32]

Furthermore, the Madres' movement is highly personalized in the sense that the mothers all suffered a similar experience. They all had the similar experience of having the same government disappear their relatives, so they could all focus their energy at an establishment and at individuals. The Madres reinterpreted motherhood to be collective rather than individual. In this sense, the disappeared child of one mother was the child of another mother.[33] This attitude probably strengthened the organization, as the disappearances were not just the business of one mother, but of all. Other NGOs may not have that same advantage over its members and therefore lack the sincere commitment that the Madres' constituents had for their cause. In this sense, they differ from most NGOs.

Conclusion

The Madres may be considered a nongovernmental organization in several respects. To recapitulate, they engage in courting the support of international actors, publish newspapers and more recently, have maintained a website to inform the public about their cause, and they attempt to create change by making evident the human rights abuses of their government. However, it seems that the Madres' organization was created as a consequence of a larger and more profound movement—that of feminism, political incorporation, democracy and human rights, among others. Although it is accurate to study the Madres from an NGO perspective, a complimentary perspective to consider the movement is from the viewpoint of the new social movement. New social movements "are inclined towards affective concerns, expressive relations, group orientation, and horizontal organization."[34] In Argentina, the human rights movement

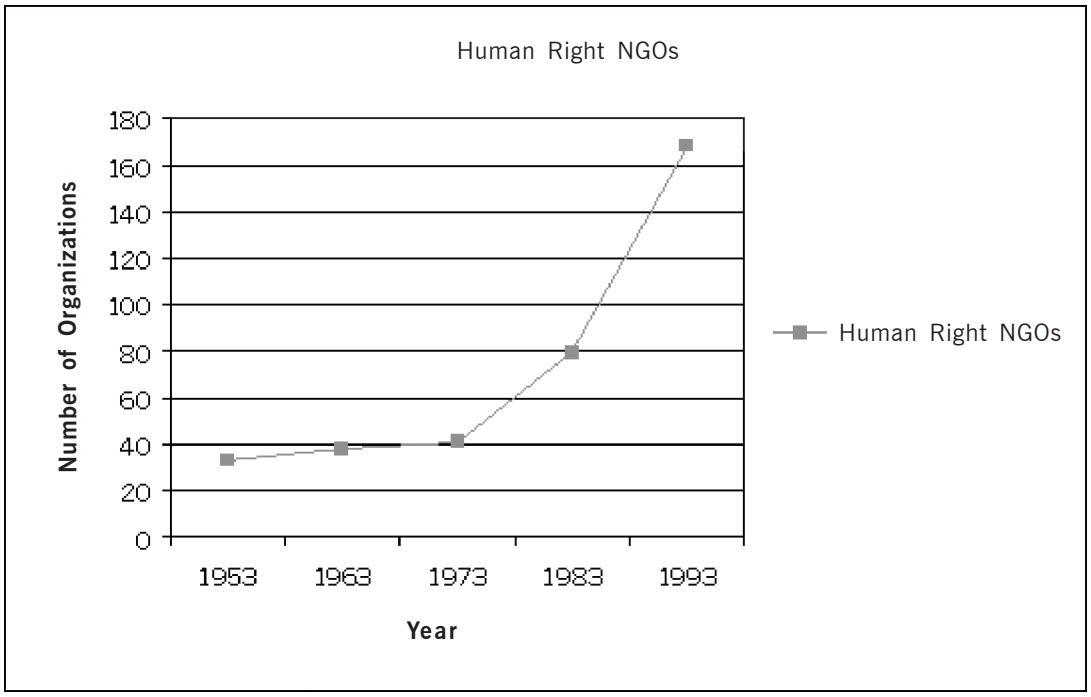
was a product of the military regime's oppression and terror. What was novel about the movement was "the absolute, non-negotiable character of its major demand—the protection for human rights, especially the right to live."[35]

At certain junctures, the Madres do not seem to follow usual patterns followed by mainstream human rights NGOs. For example, the Madres fail in the areas of ideology, historical evolution, methods of funding, constituency, chapters abroad or in the area of its relations with their government. Even if the Madres did not follow the same patterns of development as their mainstream counterparts, their operations are sufficient to warrant their study from the nongovernmental perspective. The results of their work are unclear and it would not be totally accurate to say that they played a large role in helping oust the military regime. The role that NGOs have on the international scale is hard to measure because causation is difficult to identify when there are many factors interacting. However, it is fair to conclude that the Madres were in a very different position than many other potentially "political" movements, since they were not eradicated as many parties and other organizations were. Still, we cannot conclude that the Madres were of no importance since they were left alone; we should consider that the military perceived the Madres to be sufficiently threatening to launch a campaign against them in an attempt to publicly discredit their organization.

One line of thought attempting to explain why the Madres were allowed to exist argues that if a government wanted to prove that it promoted a free society to gain favor with democratic and potentially powerful allies, then it would be in its best interest to allow organizations such as the Madres to exist. However, the Argentine military had been liquidating many "subversive" groups and did not need to put on any sort of falsity since it was so blatantly repressive. At this juncture, one of the strongest arguments for the maintenance of NGOs—that it is in the best interest of governments to promote NGOs in their system—breaks down, since it mostly applies to democratic or supposedly democratic societies. The Madres can be understood to be an anomaly amongst NGOs that operated in a different environment than most do—where it was not expected for women to challenge the government. When the Madres began to protest, the military did not know what to do with them, except to resort to name-calling. As an NGO, the Madres achieved their goal of exploiting the military through propaganda and attracting the world's attention to their abuses of human rights. However, to understand the implications and deeper causes for the Madres' existence, more points of view must be considered with care.

Appendix: Graphs & Figures

Graph 1 Existence of Human Rights NGOs, 1953-1993 at 10-year intervals



Source: Data derived from: Keck, Margaret E., Sikkink, Kathryn. Activists beyond Borders: Advocacy Networks in International Politics. Cornell University Press, Ithaca; 1998. p.11.

Figure 1 The Madres de Plaza de Mayo Protesting

Source: Las Madres de La Plaza de Mayo <http://www.gac.edu/~aarnold/madres.html> Accessed on October 20, 2001.

Figure 11 | Hebe de Bonafini participating in Havana, Cuba

Source: Cuba: Castro - Bonafini © CubaImagen <http://www.latinphoto.org/latinphoto-cgi/topixx?op=preview&ID=992603170> Accessed October 20, 2001.

Endnotes

1 See graph, Appendix.

2 The differences existing between the Madres and "mainstream NGOs" will be discussed in this paper and each will be distinguished from the other.

3 Especially vivid accounts include books such as: *Testimonio Sobre el Centro Clandestino de Detencion de la Escuela Mecanica de la Armada Argentina (ESMA).* Centro de Estuido Legales y Sociales (CEIS), 1984. This source chronicles one individuals experience of abduction and torture while listing the names of several "disappeared." Furthermore, a list military men is given, describing their alisases, rank and activity during the regime. Their photos are captioned with the word "torturador," or torturer.

4 Bouvard, Marguerite Guzman. Revolutionizing Motherhood: The Mothers of the Plaza de Mayo. Scholarly Resources Books, Wilmington, Delaware; 1994. p.24.

5 Bouvard. P.27.

6 Lavrin, Asunción. Women, Feminism, and Social Change in Argentina, Chile, and Uruguay, 1890–1940. University of Nebraska Press: 1995 P.58

7 Bouvard. P.67. In addition to this source, readers can learn more about what one author called the "Roles en Paradoja." The following source discusses the "switching or roles" between mothers and fathers, women and men during the Madres' movement. Diago, Alejandro. Conversando con las Madres de Plaza de Mayo: Hebe de Bonafini, Memoria y Esperanza. Ediciones Dialectica. Buenos Aires, 1988. P. 33.

8 This source argues that the historical manner in which NGOs in general have approached policy has evolved, moving away from a "relief and welfare" model to a planning and production-support model. Michael Cernea, "Non-governmental Organizations and Local Development," *Regional Development Dialouge* 10 (Summer 1989), 2.

9 Saksena, K.P. Human Rights Perspective & Challenges: In 1990 and Beyond. Lancers Books, New Delhi; 1994. p. 115.

10 www.amnesty.org. This source is also important because it chronicles the amount of work that was done publicly to gain support and financing for Amnesty International.

11 Ed. Boli, John and Thomas, George M. Constructing

World Culture: International Nongovernmental Organizations since 1875. Stanford University Press. Stanford, California: 1999. P. 53.

12 Bouvard P. 104.

13 www.madres.org. *Historia de las Madres de Plaza de Mayo.* Author's translation of text.

Conferencia pronunciada el 6 de julio de 1988 por Hebe de Bonafini, presidenta de la Asociación Madres de Plaza de Mayo.

14 Bouvard P. 79.

15 Bouvard P. 72, 133.

16 Bouvard P. 15.

17 Bouvard P. 88.

18 Diago. P. 28-9. Bouvard also discusses the symbolism and history of the panuelo. P. 74.

19 Diago. P. 30. Consult this source for more on the symbolism of the Plaza de Mayo.

20 Bouvard P. 77.

21 Bouvard P. 78. Azucena De Vicente, a member of the Madres, was abducted, along with a couple of nuns.

22 Diago. P. 25.

23 Diago. P. 27. Translated: "The Virgin Mary would never have acted in that manner." —Monsenor Quarracino.

24 Bouvard. P. 74.

25 Bouvard. P. 81.

26 Bouvard. P. 88-9.

27 Bouvard. P. 84.

28 Bouvard. P. 112.

29 Report of the Regional Meeting for Latin America and the Caribbean of the World Conference on Human Rights, San José, Costa Rica, 18-22 January 1993. United Nations Document: A/CONF.157/LACRM/15. February 11, 1993. Available at: http://www.unhchr.ch/html/menu5/wccosta.htm.

30 Bouvard P. 16.

31 Diago P. 57.

32 Luna, Felix. 500 Anos de Historia Argentina: Las Mujeres y sus Luchas. Editorial Abril, 1988. P.51

33 Diago. P. 34.

34 Mainwaring, Scott and Viola, Eduardo. New Social Movements, Political Culture, and Democracy: Brazil and Argentina. Working paper #33. The Helen Kellogg Institute for International Studies: December, 1984. P. 3.

35 Ibid. P. 24.

An Introduction to Neutron Imaging Along With the Status of The University of Texas Thermal Neutron Imaging Facility

The University of Texas at Austin

Undergraduate Research Journal

Volume 2
Spring 2003

Matthew A. Griffin, *The University of Texas at Austin*

This paper introduces Neutron Imaging (NI) and briefly explains what occurs during this process. Optimizations and applications, with respect to neutron imaging facilities, will be discussed as well as planned optimizations of The University of Texas Thermal Neutron Imaging Facility (TNIF).

Introduction

NI is a non-destructive technique which can provide valuable information for internal evaluation of materials or components. It has been used as a non-destructive imaging technique for over sixty years. Currently, there are less than one-hundred NI facilities world-wide (Lehmann).

How NI Works

NI produces images by focusing a beam of neutrons through a sample

medium and detecting the neutrons that come through the targeted sample (detection through attenuation). The images are comparable to X-ray radiography, but the images differ in output information due to the way neutrons react with material. X-rays react with electron clouds, and consequently X-ray attenuation depends strongly on the atomic number or weight of the atom; however, neutron attenuation does not depend on atomic number or weight of an atom, therefore neutron attenuation does not form a linear relationship with atomic weight. NI produces images similar to X-ray radiography, but it produces different and unique data, which has its own useful applications. Through the process of NI, differential attenuation of neutrons may be measured, mapped, and visualized. The resulting image may then be utilized to analyze the internal characteristics of the sample (Biegalski and Ellzey).

A comparison of neutron imagery in the form of a neutron radiograph and an X-ray radiograph is given in Figure 1. This comparison shows that neutron radiography has the capability to reveal detailed components that are not visible in an X-ray image.

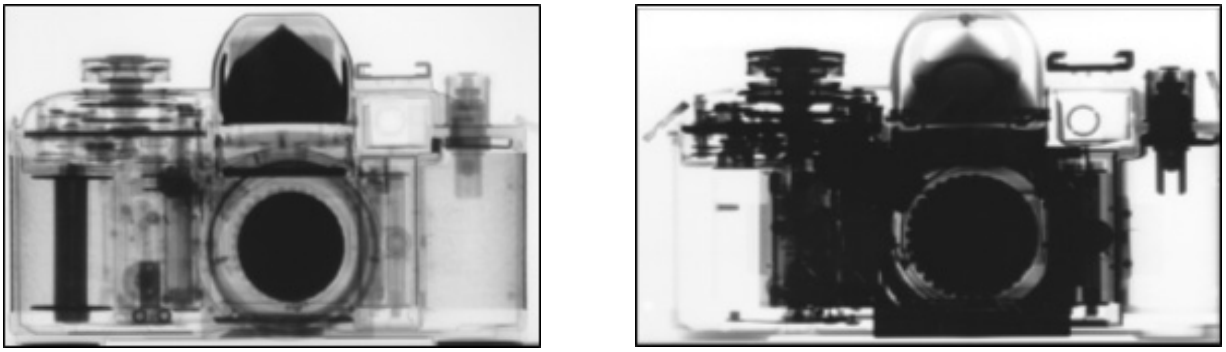
Some light elements, such as hydrogen and boron, have high thermal neutron attenuation coefficients, while some heavier elements, such as lead and iron, have smaller thermal neutron attenuations. The attenuation of thermal neutrons gives NI a useful property such as providing valuable images of materials like steel and heavy metals. NI can accomplish this because thermal neutrons can penetrate these materials. In contrast, X-rays are significantly attenuated in heavy metals and may not be utilized for imaging these materials making NI a powerful non-destructive imaging technique.

Process of Neutron Imaging

The process of NI involves detecting the attenuation of a beam of neutrons through the sample to be imaged. This requires a neutron source, collimator, sample positioning system, object to be imaged, and a detector. The design of a system can be complicated due to the wide variation of components.

Nuclear reactors, although expensive, large, and immobile, are typically the chosen sources for NI facilities. Other possible types of neutron sources available for NI include accelerator tubes and radioactive sources. Collimators, which are typically custom constructed for each NI facility, direct the neutron beam. Sample positioning systems are usually motor controlled and can vary in size and make. NI detectors vary from special films, trach-etch film, imaging plates, a-Si:H panel, microchannel plates, charge-coupled device cameras, and real-time cameras with intensifiers.

Figure 1 a. Neutron Radiograph of Camera
b. X-ray Radiograph of Camera



Source: Lehmann

Applications/Optimizations

There are many practical and scientific applications of NI. Due to the ability of neutrons to penetrate most heavy metals, NI can be effective in determining internal clearances between parts, and checking for internal defects such as voids or cracks. Since neutrons have a high probability of interacting with hydrogen, NI is useful in revealing hydrogen contained in materials such as corrosive products and water. It is also useful in examining nuclear fuel because of neutrons' sensitivity to fluctuations in nuclear fuel and the ability of neutrons to penetrate nuclear fuel casing.

Some of the current uses of neutron imaging at other neutron imaging facilities (Ward Center, NRAY services, and NEUTRA) include:

- Real time imaging of larval movement in soil
- Two phase flow of liquid and vapor plant root growth in contaminated and/or compacted soils
- Measuring effectiveness of moisture repelling agents in building materials
- Imaging shock waves in gases
- Quantitative evaluation of nuclear fuel pin structural features
- Imaging fluid spray patterns and dynamics
- Bonding flaws in adhesives
- Authenticity of artifacts uncovered through archaeological digs
- Corrosion within aluminum products
- Hydrogenous foreign substances in sealed units
- Explosive loading uniformity
- Autoradiography of oil paintings
- Pressure determination of nitrogen gas in stainless-steel containers
- Inspection of Pu in UO_2-PuO_2 pellets
- Study of internal combustion engines and fluid flow
- Study of drying and wetting processes in wooden materials
- Process analysis of batteries and electric fuel cells (cf. "Neutron Radiography", "The Neutron Radiography Program at PSI", "Services")

Optimizations

With new improvements in computer hardware and software, many NI facilities are upgrading to utilize computerized storage and image processing software. Tomography is becoming more accessible with the advance of computer technology and is being integrated into more NI systems. Improved sources, collimators, object stands, and detectors are also being utilized to upgrade systems. For instance, a new detector system called a borated micro-channel plate imager is capable of resolutions as small as 25 mm (Huergo).

The University of Texas Thermal Neutron Imaging Facility

The Thermal Neutron Imaging Facility (TNIF), located at The University of Texas Nuclear Engineering Teaching Laboratory, consists of a TRIGA Mark II research reactor. Completed in 1998, TNIF was constructed as a neutron radiography and computed tomography facility (Jo). The reactor and collimator produce neutron beam characteristics optimized for NI. The sample positioning system consists of a motor powered, auxiliary controlled stand that can move in all directions. The current imagery system at TNIF consists of an intensifier, which is an image tube, and a real-time camera. The resolution of the TNIF is approximately 200 mm.

Research at UT's TNIF

A research project which involves measuring temperature profiles of hydrogenous gasses in porous materials is currently in the planning stages. This state of the art application of neutron attenuation applies nuclear techniques to the field of combustion in porous media. Data obtained in this project will lead to a better understanding of the combustion process in porous media and consequently lead to improvements in porous burners. This improvement in burner technology should lead to lower emissions in radiant heaters and gas turbines along with improvements in many other areas where porous burners are used (Biegalski and Ellzey).

Optimizations of UT's TNIF

Since The University of Texas TNIF is fairly dated, modifications are in progress to optimize the system. Optimizations include upgrades to the software, shield-

ing, and detector for the TNIF. Software optimizations involve integration of the motor controller and imagery by using different computing techniques. The improved shielding proposed will enhance the TNIF detection. A new neutron imaging system that consists of a borated microchannel plate imager is being investigated. With the new type of imaging system, resolutions of less than 25 mm (currently around 200 mm) should be achieved (Dorse and Charlton).

Optimizations currently in progress will not only upgrade the functionality and flexibility of TNIF, but additional work may develop the capability to create three dimensional or tomographic images, which will help visualization of data and in turn improve the quality of research. These optimizations of the TNIF will not only modernize operations, but also allow for vanguard applications of neutron imaging.

Conclusion

In closing, neutron imaging, which has proved to be an effective imaging tool, produces unique data that can lead to improvements in everyday life. While NI is comparable to X-ray images, imaging with neutrons produces different, and in some cases more useful, information (due to neutrons' ability to penetrate different materials). While X-ray imaging is wide spread, neutron imaging remains less accessible. This accessibility is not due to NI's capabilities, but to economics and familiarity. The cost of NI is substantially higher due to shielding concerns and the way neutrons are produced.

Many people and companies are unaware of NI and therefore do not take advantage of the useful information NI can obtain, especially in high tech applications such as the aerospace industry and high tech manufacturing. Unfortunately, NI is also fairly inaccessible to industry and the public, since demand is low and the process is fairly expensive.

If imaging with neutrons were more accessible it could be helpful in many aspects. Two of these include security checkpoints and private industry. Security checkpoints, such as ports, could be safer with the implementation of NI. If NI were used along with X-rays in such checkpoints, the spectrum of imaging would be far greater. NI would be able to penetrate many crates and casings that X-rays could not. Although using NI at ports and other security checkpoints is currently uneconomical, it could be useful in high security areas. Private industry can profit from NI with research that will lead to better materials, such as moisture prevention in materials and porous burner design. NI can also be useful by providing visual information for parts with high specifications and low building tolerances, or even reverse engineering.

Although NI has been around for over sixty years, many possibilities of advancement remain in the field of NI, which will further improve the average person's quality of life. With respect to the average person, NI can improve the standard of living through better materials used in a variety of applications, more efficient security measures, and improved manufacturing through visual tolerances of high tech applications. Upon completion of the upgrades currently in progress at The University of Texas TNIF, this facility may play an integral role in improving technology in many facets of life. The planned project involving research in porous burner technology should improve efficiencies and therefore reduce emissions.

References

Biegalski, S. and Ellzey, J. "Utilization of Neutron Radiography for Measuring Temperature Profiles of Hydrogenous Gasses in Porous Materials." NERI Application, 2003.

Dorse, D.J. and Charlton, W.S. "Recent Developments and Applications for the University of Texas Thermal Neutron Imaging Facility." The University of Texas. 2000.

Huergo, J. " Neutron Imager for Faster, Better Images." Ballistic Missile Defense Newsletter, Winter 2001-2002, Issue #40.

Jo, Young Gyun. "Development of a Thermal Neutron Imaging Facility for Real Time Neutron Radiography and Computed Tomography." Ph.D Dissertation. University of Texas at Austin, 1998.

Lehmann, E.H. "Neutron Imaging." Proc. 18th Summer School on Neutron Scattering, Publ. World Scientific Publishing Co. Ltd, ISBN 981-02-4444-4 (August 2000)

"Neutron Radiography." The Ward Center for Nuclear Sciences. 3 September 2002 <http://www.osp.cornell.edu/vpr/ward/NRay.html >

"The Neutron Radiography Program at PSI." Paul Scherrer Institut. 3 September 2002 <http://neutron.web.psi.ch/program/index.html>

"Services." NRAY Services Inc. 3 September 2002 <http://216.126.89.183/services.htm>

Suburban Neighborhoods: Design, Lifestyle and Community

The University of Texas at Austin

Undergraduate Research Journal

Volume 2
Spring 2003

Sarah Cary, *The University of Texas at Austin*

"Oh, Thebes, may you be crowned in ivy, and may you...run fruitful and green," cries the chorus in Euripides' *Baccahae* (Euripides 5). This ancient play premiered in the Theater of Dionysus in Athens around 407 B.C., and is still performed in countless theaters today. Euripides' work was merely a fraction of the intense philosophical debates that established the Greek city-states as magnets of culture, public debate, literature, and political philosophy.

Cities such as Thebes and Athens flourished intellectually and laid the foundations of Western civilization because they were designed to do so; the spatial arrangement and emphasis on public buildings such as the Theater of Dionysus fostered intellectual citizen interaction and debate. The value of Athens was not solely in the beauty of its buildings, but in the public environment those buildings created for its citizens. Greek cities reflected Aristotle's vision of democra-

cy, which emphasized the public sphere rather than of individual freedoms.

This research looks at the modern relationship between form and lifestyle. When compared to other Western cultures, cities in the United States are characterized by separated land uses, complete dominance of the automobile, single-family houses and a dearth of public space. What kind of civic, cultural, and individual life does the built environment and urban layout of the current America create? To what extent does the spatial arrangement of our lives affect the mental arrangement of our lives? *Is there a connection between the physical form of a neighborhood and the residents' sense of neighborhood community, or their sense of connection to the larger city?*

Background

Sociologists, historians and political scientists have long debated how the physical design of a society relates to its social and political structure. When American cities began to explode into metropolises, sociologists studied the general effects of Urbanism on individuals, and as Americans fled the city after World War II, scholars asked what constitutes a neighborhood or community and they studied the role it played in an individual's life.

Luis Wirth, a sociologist at Chicago University in the 1920s, believed that the built environment of the American city took away individual rights because it forced people to depend upon on others to survive. He also derided the density and heterogeneity of the city because together those qualities encouraged residents to congregate according to superficial qualities like skin color or age. Throughout his analysis, Wirth contrasted Chicago with small town Illinois (Wirth 98-105).

Working in the 1950's, Herbert Gans moved to Levittown to research how the form of the post-war suburban communities affected the lifestyle of the inhabitants. He concluded that the suburbs, with their family-centered design, deceived residents into believing that the individual home is the focus of life. Gans disagreed with this design, believing that the individual home could not be the primary focus in a democratic, pluralistic, and heterogeneous America (Gans 64-68).

In the early 1990s, the Brookings Institution funded a study on the impact of the built environment upon local democracy in the United States. The study, conducted over several years in five cities, found that the relationship between participatory democracy is more closely related to the urban environment than to the race or socioeconomic status of the neighborhood, although the preexistence of community organization is the largest factor. Specifically, the study found that "that sense of community is not dependent on socioeconomic status"(Berry 238), a finding essential to this research project.

In 1993, Robert Putnam "developed a theory of social capital to explain the effect of decreasing community participation and civic engagement on declining institutional performance" (Blanchard 225). Social capital means a communities sum network of personal connections. Putnam focused on social capital's impact on civic engagement, by which he meant formal involvement in civic activities, from Girl Scouts to the Kiwanis club. His intensely documented evidence shows a strong relationship between civic engagement and the performance of social and governmental institutions. Putnam believed that the decline in American social capital was the product of social factors such as mobility, not specific design qualities (Putnam).

Research Question

Is there a connection between the physical form of a neighborhood and the residents' sense of neighborhood community or their sense of connection to the larger city?

This research question, attempts to stretch and define the limits of the relationship between form, the built environment, and the lifestyle of a society. Can the connection between a place and the behavior it engenders be deepened and applied to a specific neighborhood? What specific design qualities, such as street layout, or neighborhood density, might affect the residents' level of civic awareness?

Hypothesis

Civic life begins with one's immediate surroundings, with the interaction with one's neighbors. Also, there is a connection between the design of a neighborhood and the residents' attitude toward the greater city. A neighbor-

hood that is connected to the larger city street system, designed with pedestrian-friendly streets, and has a diversity of nearby activities and stores will lead to a greater sense of community. A neighborhood design encouraging pedestrian activity or use of public transportation will have residents who are more aware of civic issues and more willing to participate in public political processes such as voting.

Method

To evaluate residents' lifestyle patterns and opinions on the community and civic life of their neighborhood, I conducted a survey in three Austin neighborhoods. All three neighborhoods contained similar demographic profiles yet possessed different physical qualities. Survey questions concerned the residents' opinions about their own neighborhood, participation in that neighborhood, lifestyle, and their awareness of larger city issues. In comparing survey results across the three neighborhoods, I searched for a relationship between design and community.

Survey data was collected from three Austin Neighborhoods: Zilker Park Neighborhood, Windsor Park, and Westgate, which were chosen for their demographic similarities according to census 2000 data. The three major variables were age, with the most populous cohort of 25-34, housing type with 'families with children' holding 15-25 %, and the owner occupancy rates, with each neighborhood possessing 40%. Variables of race and income were ignored in this demographic comparison because the Brookings Institute Study found that socioeconomic status had no effect upon a sense of community.

The survey employed a systematic method of choosing the houses for the survey - every third house, with a total of 330 houses in each neighborhood receiving surveys. Because each neighborhood is differently sized, some sections of a neighborhood did not receive surveys at all, but an attempt was made to locate the surveys in similar single-family homes. Random sampling would have been preferable, but the expense and time required to gain individual addresses was prohibitive. On-site research was also conducted at each neighborhood, recording data about their street layout, land use, and stylistic features such as house setback from road. Observations of public behavior patterns factored into the analysis of each neighborhood.

Neighborhoods

Zilker Park is a 1920's suburb of Austin, built just south of Town Lake between Zilker Park and South Lamar. It is a physically diverse neighborhood, with varied housing styles and yard treatments. However, there exists an overall sense of unity and uniformity in the neighborhood because of the narrow grid system to the streets and the similar house setbacks. The dense grid means that when walking down the street, you pass more houses in one block than when compared to a more traditional suburb. Beyond simply being interesting to look at, this allows for more houses and more retail shops in a smaller area, ensuring destinations for pedestrians. Narrow streets with speed bumps ensure that traffic is safe and calm.

Windsor Park is a 1950s suburb located directly adjacent to Interstate 35 and north of 51st street. Built as tract housing immediately after WWII, Windsor Park is now surrounded by declining apartments and strip shopping malls. Economically diverse, the neighborhood is planned across an elongated and curved grid of streets, with traffic directed across the north-south streets. The neighborhood is less pedestrian friendly than Zilker Park because the nearby retail is designed for the car, the retail is farther away, the major streets do not have speed bumps or clear sidewalks, and the neighborhood is isolated by large, heavily trafficked streets.

Westgate is the most recent of the neighborhoods I surveyed, built in the 1970s on the outskirts of Austin's city limits. Located south of a large highway, the neighborhood contains houses of a similar but not identical style, laid out over small cul-de-sacs and curving, irregular streets. Westgate's proximity to retail and other services parallels that of Windsor Park, however such facilities are more difficult to reach on foot in Westgate. The neighborhood is isolated among busy four-lane road that lacks sidewalks, and there is only one street which runs the full length of the neighborhood; both qualities

prohibit easy walking from the residential area to retail, and discourage other destinations.

In keeping with the hypothesis, I would expect the older suburb of Zilker Park, with a grid layout, pedestrian friendly streets, and nearby retail to have a greater sense of community and be more interested in Austin civic issues, while Westgate, with its 1970's cul-de-sac design of isolation would fare worse.

Results

Out of a distribution of 990 surveys, 393 were mailed back to me. A 40% return rate is incredibly high for mail surveys; approximately double the usual return rate of 20%. The returned surveys were distributed evenly across the neighborhoods, with each neighborhood returning over 100 surveys.

The results indicated the following: 1) survey respondents varied considerably from Census 2000 demographic data, however the neighborhoods were still demographically parallel, 2) the overall design of the neighborhood did not directly influence a residents sense of community, participation, and civic awareness, 3) other factors such as length of residence or age had a slight impact, and 4) the propensity of a respondent to walk was directly connected to the design of the neighborhood, and had a large effect on the respondent's sense of community.

In each neighborhood, respondent demographics varied considerably from the Census 2000 data, however the demographics were still similar across all three neighborhoods. For example, the median age, according to the census, was 25-34 in all three neighborhoods; the median age of survey respondents was 'over 50' across all three neighborhoods. This proven demographic similarity allowed the research to focus on how the physical design of the neighborhoods might affect the sense of community.

However, my hypothesis was not validated. The null hypothesis held true: that there is no difference in respondent's answers to sense of community, participation or civic awareness between the three neighborhoods. Only six of the twenty-one questions resulted in a difference between neighborhoods that could be correlated to the design of the neighborhood. As a primary indicator, an average of 45% of the respondents, across all neighborhoods, felt a "strong sense of community with others in your neighborhood." While Zilker Park had a greater number of respondents who circled a "very strong sense of community," the difference is not significant when compared to the overall variations (See Table 1).

Factors besides the physical design of the neighborhood which have an impact on the sense of the community include length of residence, age, and the propensity to walk in one's neighborhood. The length of residence does have a discernable pattern on a resident's sense of community; 40 % of the people who circled a very strong sense of community had lived in their neighborhood for longer than twenty years. Only 30 % of the people who found "very little sense of community" with their neighbors had lived in their neighborhood for longer than 20 years. While the relationship is not directly parallel, there is a tendency for the people who feel a greater sense of community to have lived in their neighborhood for a longer period of time than those who lacked a sense of community.

The most striking results came from a lifestyle question, "do you walk in your neighborhood more than once a week?" Not only does walking influence the number of neighbors a resident recognizes, walking also correlates strongly with a resident's sense of community (see Table 2). Zilker clearly has more walkers than the other neighborhoods; I believe their tendency to walk lies in the design of the neighborhood. Zilker is by far the neighborhood most conducive to walking: it has nearby destinations, retail, varied and unique scenery, a grid street layout, and the main streets feel safe. According to this survey, such qualities of design help foster a sense of community by encouraging a pedestrian use of the streets. Putnam, referring to social capital, emphasized the importance of "loose networks," or people one knows as acquaintances, and how these networks create a sense of community even more effectively than smaller, tightly knit groups of people (Putnam 205-215). I believe this helps to explain how walking is connected to the sense of community – people who walk often constantly see their neighbors, creating a sense of community even if they do not personally know their neighbors.

While the qualities of age, length of residence, and walking depend upon the neighborhoods, none of their connections to community were strong enough to draw a relationship between individual neighborhood design and sense of community. The overall layout of a neighborhood is not directly connected to a sense of community, but smaller design features do have a have large impact on the quality and character of the neighborhood by affecting residents propensity to walk.

Future Research

Overall, the survey showed me that the relationships between design, lifestyle, and community are extremely complicated and lack a clear path of design to follow. The survey invariably raises new questions about the relationship between design and lifestyle, and how they affect the resident's sense of community.

Primarily, the survey raises questions about the extent and relationship of loose networks, and to what extent the structure of such networks extend. The survey indicates that besides the encouraging longer residences, the best design stratagem is to design for pedestrian movement. Future research should build upon this survey with another questionnaire that asks more detailed questions about community and that also attempts to obtain greater physical discrepancies between the neighborhoods surveyed. This might require expanding between several cities to ensure a greater range of middle class family housing styles, but gaining more range among physical designs would test the limits of the relationship between design and society.

Other questions would ask exactly how residents gained their sense of community; did it grow as they resided in the neighborhood longer, or did their opinion hold steady over many years. Additionally, "If you walk more than once a week in your neighborhood, where do you walk to and why?" could be an especially helpful question, because I had to assume from my own personal observations that the nearby retail or parks were the destinations for pedestrians in Zilker. All these questions would elucidate further the complex relationship between design, neighborhood use, and perception of community.

Acknowledgement

I would like to thank Professor Anne Beamish for her wise and generous support throughout this process. I am indebted to The Vice President of Research at the University of Texas in Austin for granting me essential financial support for this research. Special thanks to my friends Melanie Tong, Jesse Lovegren, Vivek Prakash and Guilluame Lamazare for their emotional backing and assistance in distributing surveys.

Appendix: Graphs & Figures

Table 1 Sense of Community

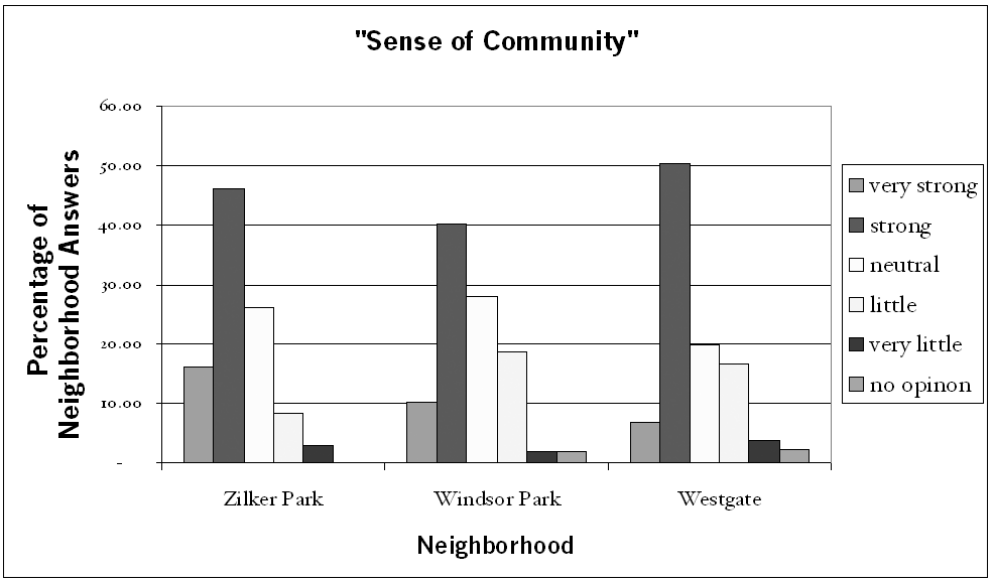
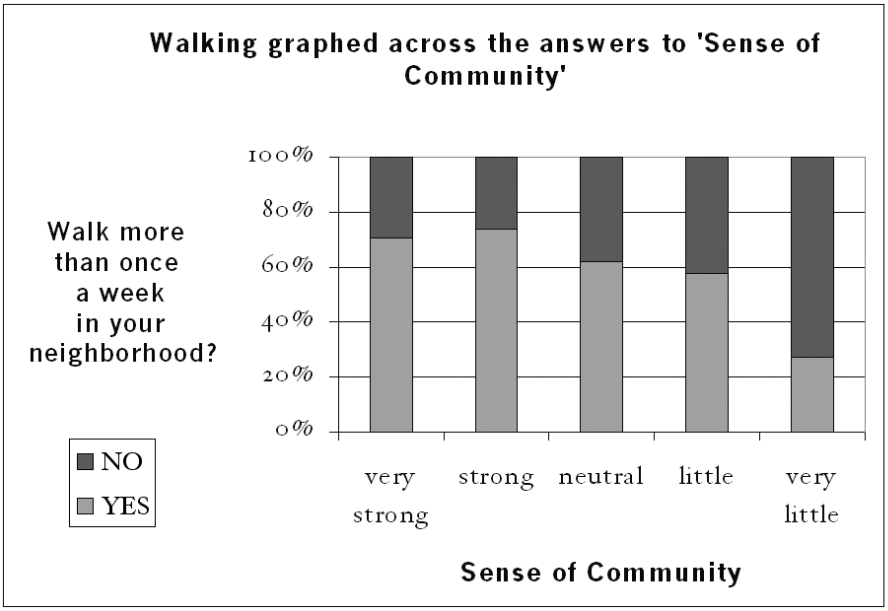


Table 2 Walking graphed across the answers to 'Sense of Community'



References

Berry, Jeffrey M. Rebirth of Urban Democracy. Washington D.C: Brookings Insititution, 1993.

Blanchard, Anita and Horan, Tom. "Virtual Communities and Social Capital." Virtual Communities and Social Capital. Claremont: Idea Group Publishing, 2000.

Euripides. Bacchae. Trans. Paul Woodruff. Indianapolis: Hackett Publishing Co, 1998.

Gans, Herbert J. "Levittown and America." The City Reader. Ed. Richard T. LeGates and Frederic Stout. Vol. 2nd Edition. New York: Routledge, 1996.

Putnam, Robert D. Bowling Alone. New York: Simon and Schuster, 2000.

Wirth, Louis. "Urbanism as a Way of Life." The City Reader. Ed. Richard T. LeGates and Frederic Stout. Vol. 2nd Edition. New York: Routledge, 1996.

An Example of Chaos in a Differential Equation

The University of Texas at Austin

Undergraduate Research Journal

Volume 2
Spring 2003

Katherine A. Bold, *The University of Texas at Austin*

"Chaos" has been a big part of popular mathematical literature lately, especially in reference to a butterfly far away flapping its wings. Just imagine a butterfly flapping its wings and creating a disturbance in the air. This disturbance can propagate halfway around the world, possibly resulting a hurricane or tornado. That might be a little hard to believe, but it is an example of the concept of a slight change in initial conditions (a butterfly flapping its wings) in a system (the Earth's atmosphere) growing into drastically different behavior in the system (a hurricane or tornado).

The "mistake" of a slight change in initial conditions was part of an early investigation of chaotic systems. Edward Lorenz, a meteorologist, ran simulations on the atmosphere using input with several digits after the decimal point. Later when he ran the simulations again, however, he took a shortcut and only entered the first few digits

after the decimal point. Much to his surprise, the results were drastically different (Strogatz, 2-4).

Here we will discuss one definition of chaos that relies on the idea of sensitive dependence on initial conditions. We will investigate two simple systems; one will be chaotic, the other not. Then we will see how the ideas from our simple chaotic system can be generalized to analyze a system resulting from a differential equation, the Forced van der Pol Equation.

A Mathematical Definition of Chaos

More than one definition of chaos is used in mathematics, and here we will focus on a not-too-technical definition. This definition is slightly changed from that given by Devaney in (Devaney).

An attractor of a system is *chaotic* if

- it has sensitive dependence on initial conditions
- periodic orbits are dense
- it has a transitive orbit

Now let's go through and figure out what this definition means. A system is some set with an associated map. An example of a system is the set of real numbers (R) with the squaring map ($f(x) = x^2$). An attractor can be thought of as "where the points end up" after a lot of iteration, or the set of limit points. The finite limit points of our example system will be $0,1$. Note that all points will go to $0,1$, or positive infinity.

We have already discussed sensitive dependence on initial conditions a little. An attractor has sensitive dependence on initial conditions if two points can be chosen close together that will be far apart after some number of iterations of the function. Think about our system (R, f). Let $x_0 = 0.999999$ and $x_1 = 1.000001$. x_0, x_1 are close together, but after applying f to each one many times, they will be far apart ($f^n(x_0) \to 0$ and $f^n(x_1) \to \infty$ for large n). We are concerned with sensitive dependence within the attractor. The points in the attractor $(0,1)$ are not near each other, and there is not sensitive dependence on initial conditions. If you take any point near 1 in the attractor, you can only take the point 1, and the same for any point near 0. Thus, we cannot find points nearby that diverge.

The next criterion concerns periodic orbits being dense. A periodic orbit is a sequence $\{x, f(x), f^2(x) = f(f(x)), \ldots, f^n(x)\}$ such that $f^{n+1}(x) = x$. In our attractor $\{0\}$, $\{1\}$ are the only periodic orbits; in fact, they are called fixed points because $f(x) = x$. If any sequence $\{y, f(y), \ldots\}$ can be approximated well by periodic orbits, then we say the periodic orbits are dense. Are periodic orbits dense in our attractor? Yes, but this is trivial because the only points in the attractor are fixed points.

The last condition for a system to be chaotic is the existence of a transitive orbit. A transitive orbit $\{x, f(x), f^2(x), \ldots\}$ will visit, or get arbitrarily close to, every point in the attractor. Our system does not have a transitive orbit. The only orbits in the attractor are fixed at 0 or fixed at 1; an orbit starting at 0 cannot reach 1, and an orbit starting at 1 cannot reach 0.

In the definition of chaos Devaney gives, the third condition is that the system be topologically transitive. We will state what it means for a system to be topologically transitive but not go into it anymore. A system is topologically transitive if for any open sets U, V there exists an n such that $f^n(U) \cap V \neq \emptyset$. The existence of a transitive orbit implies that a system is topologically transitive.

Now we have gone through the definition of a chaotic system and seen an example of a system that is not chaotic. If we had looked instead at the map $f(x) = 4x(1-x)$, we would have had a slightly harder time analyzing the system. You can show that this map on $[0,1]$ is chaotic. Another similar, more interesting system we could have looked at is (C, f), where $C = \{z = e^{2\pi i\theta} \mid \theta \in R\}$, complex numbers on the unit circle, with $f(z) = z^2$. The system (C, f) is chaotic.[1]

A Chaotic System

The next system we investigate is a little abstract. The set Ω will be all sequences with only 0s and 1s. For example, the sequences $(0\ 1\ 0\ 0\ 0\ \ldots)$, $(1\ 1\ 0\ 0\ 1\ \ldots)$ will both be in Ω. In general, $x \in \Omega$ will be represented by $x = (x_0\ x_1\ x_2 \ldots x_n \ldots)$. Two sequences will be considered close if their first n entries are the same; they will be far apart if their first n entries are different. The function on Ω will be a shift map, σ. $\sigma(a) = \sigma(a_0\ a_1\ a_2 \ldots) = (a_1\ a_2 \ldots)$. So, σ chops off the first term in a sequence. σ^n means applying σ n times,

or chopping off the first n entries, $\sigma^n(a) = (a_n\ a_{n+1} \ldots)$. This may seem like a simple system, but we will see it is chaotic according to our definition. The attractor is the whole space, so we will talk about the whole system.

First, the system has sensitive dependence on initial conditions. Let $a = (a_0\ a_1 \ldots a_{N-1}\ 0\ 0\ 0\ 0 \ldots)$, $b = (a_0\ a_1 \ldots a_{N-1}\ 1\ 1\ 1\ 1 \ldots)$. a,b agree for their first N entries, so they are close together, and the entries of $\sigma^N(a)$, $\sigma^N(b)$ are completely different, so they are far apart. Thus, two sequences can be constructed arbitrarily close together that will be far apart after N iterations of σ. Note there are no restrictions on the first N entries, so these sequences can be chosen from throughout Ω.

The next criterion to consider is if periodic orbits are dense. This means that given some sequence $a = (a_0\ a_1\ a_2 \ldots)$, periodic points can be constructed arbitrarily close to a. Consider

$x_0 = (a_0\ a_0\ a_0 \ldots)$

$x_1 = (a_0\ a_1\ a_0\ a_1\ a_0\ a_1 \ldots)$

...

$x_N = (a_0\ a_1 \ldots a_N\ a_0\ a_1 \ldots a_N\ a_0 \ldots)$

For large n, x_n is arbitrarily close to a. Thus, periodic points are dense in ?.

The final criterion to consider is the existence of a transitive orbit. We want to find some $a \in \Omega$ such that $\sigma^i(a)$ is arbitrarily close to any sequence in ? for some i, where i is the number of iterations of σ. Let $a = (0\ 1\ 0\ 0\ 0\ 1\ 1\ 0\ 1\ 1\ 0\ 0\ 0\ 0\ 0\ 0\ 1 \ldots)$. a is constructed by listing all sequences of length 1, all sequences of length 2, all sequences of length 3, etc. Thus, arbitrarily long approximations of every sequence are contained in a. a is a transitive orbit, so (Ω, σ) has a transitive orbit.

As we have seen, (Ω, σ) satisfies the three conditions for a chaotic system, thus it is a chaotic system. This is an example of a seemingly simple system having complicated behavior.

Generalizations of the Previous Example

The system (Ω, σ) can be interpreted as in Figure 1. The graph is interpreted as follows: if an arrow goes from 0 to 1, then in the sequence space Ω, a 1 can follow a 0 in a sequence. So, 1,0 can follow 0 or 1 in the space.

We can generalize (Ω, σ) to be sequences containing more than just 0s and 1s, as in Figure 2. For the system in Figure 2, the arrows have the same meaning as before. A further generalization is to give more of a meaning to the arrows. Consider the system in Figure 3. A,B,C are subsets in a system (X,f). An arrow from A to B means that B is contained in $f(A)$.

For each of these generalizations, an analysis similar to that in the previous section shows that these systems are also chaotic. Next we will analyze a system arising from a differential equation using the ideas of the system represented in Figure 3.

The Forced van der Pol Equation with Canards

Before we get to an analysis similar to those given previously, we will discuss the forced van der Pol Equation with canards. The forced van der Pol equation is

$$x'' + \lambda(x^2 - 1)x' + x = a\sin(\omega t) \qquad (1)$$

If we let $t = \tau/\mu$, $y = x'/\mu^2 + x^3/3 - x$, $\varepsilon = 1/\mu^2$, $\omega = \lambda\mu$, and $\Theta = \omega t$, we get the full system

$$\varepsilon x' = y + x - x^3/3$$
$$y' = -x + a\sin(2\pi\Theta)$$
$$\Theta' = \omega$$

Solutions of this system of differential equations have a "jump" behavior. They will flow near the surface $y = x^3/3 - x$ for $|x| > 1$, and jump to another sheet of the surface when $|x| = 1$. This system can be decomposed into stable ($|x| > 1$) and unstable ($|x| < 1$) regions. Most of the time, solutions will stay in stable regions, but some will go into unstable regions for brief periods of time. These solutions that go into unstable regions are called canards. A map can be derived from this system by analyzing the flow of the system over certain x values.[2]

We will consider the reduced system, which we get by taking the limit $\varepsilon \to 0$ (equivalently, $\mu \to \infty$). This limit with appropriate scaling and incorporating the jumps of the van der Pol cycle gives a 2-dimensional reduced system.

$$\Theta' = \omega(x^2 - 1)$$
$$x' = -x + a\ \sin(\Theta)$$

We will use $([0,1], H)$ as the system to analyze the forced van der Pol equation with canards for certain parameters (A, B, C defined below). H is the Half

Return Map and is depicted in Figures 4 and 5 with parameter values $(a, \omega) = (1.1, 1.57)$. H is calculated by numerical integration, and the steep vertical segments correspond to canards.

The subsets of $[0,1]$ of interest are marked A,B,C in Figure 4. $A = [x_1, x_2]$, $B = [x_2, x_3]$, $C = [x_3, x_4]$. In describing this system, we will draw an arrow from A to B if B is contained in $H(A)$ (we say that "A covers B"). In terms of the intervals, this means $B = [x_2, x_3]$ is contained in $H([x_1, x_2]) = H(A)$. It is easy to see that each of A,B,C covers A,B,C with this map. First, consider A.

Imagine picking up the image of the interval A and laying it down on the Θ axis (this corresponds to the interval $[H(x_1), H(x_2)]$). Note that $H(x_1) < x_1 < x_2 < x_3 < x_4 < H(x_2)$. Thus, A,B, and C are all subsets of $[H(x_1),H(x_2)]$. A covers A, B, and C.

The same analysis shows that B and C each cover the three sets. The image of B gives $[H(x_2), H(x_3)]$, and each interval A,B,C is contained in $H(B)$. The image of C gives $[H(x_3),H(x_4)]$, which covers each of A,B,C.

Thus, we can construct a graph for this differential equation system similar to the graphs constructed for sequence spaces. It can be shown there is a correspondence between valid sequences from the graph and orbits in the system. It can also be shown that the sequence space corresponding to this graph is chaotic. This shows that the system from the forced van der Pol equation is chaotic for these parameter values.

Remarks

The ideas developed here, specifically analyzing a chaotic system, have significant consequences in real world applications ranging from circuit analysis and space flight controls to population models.

The sort of analysis that was used for the forced van der Pol equation is referred to as Symbolic Dynamics. Symbols (A, B, C) represent a part of the system (intervals), and the dynamics on the symbols are analogous to the dynamics in the actual system.

Endnotes

1. For more information on these two systems, see an introductory book on dynamical systems, such as one of the books by Devaney.

2. This brief discussion does not do justice to understanding this system. For more information, see Guckenheimer, Bold.

References

Bold, Katherine A. "REU Project on the Forced van der Pol Equation." 15 August 2002. 14 November 2002. <http://www.mathlab.cornell.edu/-katybold>

Devaney, Robert L. *A First Course in Chaotic Dynamical Systems*. Perseus Publishing. 1992.

Guckenheimer, J. Hoffman, K. Weckesser, W. "The Forced van der Pol Equation I: The Slow Flow and its Bifurcations" *SIAM J. App. Dyn. Sys.* (2002), in press.

Strogatz, Steven. *Nonlinear Dynamics and Chaos*. Perseus Books Publishing, LLC. 1994. 1-5.

A Poisson Model for Quantity Purchase Decisions of Households Estimated using Retail Scanner Data

The University of Texas at Austin

Undergraduate Research Journal

Volume 2
Spring 2003

Shobana Sankaran, *The University of Texas at Austin*

The application of statistical techniques to consumer purchase data to analyze consumer decisions has received considerable attention in the quantitative marketing literature. Empirical analysis of consumer purchase data enables the marketing researcher to uncover the factors that drive a consumer's purchasing decisions and thus predict product demand. Understanding product demand is vital to marketers. A good model of demand enables the marketer to make better and more informed decisions on the allocation of promotional dollars, advertising expenditures and on holding product inventory. In frequently purchased product categories, like grocery products, three key aspects of consumer behavior are considered important from the point of view of a manager making these decisions. These can be described as a) *consumer purchase incidence* – will the consumer purchase in the category, b) *brand choice* – if the

consumer purchases in the category, which brand will he or she purchase, and c) *purchase quantity* – conditional on purchasing a particular brand, how many units will the consumer purchase? These three questions are fundamental to the quantitative analysis of consumer purchase behavior, and warrant careful study (Leeflang et al). In this paper, I will focus on the third aspect of consumer behavior – that is, purchase quantity. I will aim to build a simple model of the quantity decisions of consumers purchasing a grocery product, and estimate the parameters of the model using real-world data for consumer-purchases in an American city.

The aim in developing this model is to understand and demonstrate how a simple model of purchase quantity can help the marketing manager relate consumer purchase decisions to key marketing-mix variables like prices and promotions. Having developed the model, the marketing manager could predict how consumers are likely to respond (by changing the number of units that are purchased) to changes in the price of the product and to the level of promotions for the product. This enables the apriori quantification of the expected losses or gains associated with strategies that the manager would want to consider, thus enabling him or her to make better decisions. The important point to note here is that though the substantive implications of various strategies are known in advance – for example, that increases in price would be expected to reduce the number of units bought by consumers, and that increases in promotions would be expected to increase the number of units bought by consumers – the amount by which these strategies will affect demand is not known. The aim of the statistical analysis is to quantify *how much* the number of units bought by consumers will fall on average due to a given increase in price, or rise on average due to a given increase in promotion levels. The results predicted by the model will depend on the data used for the estimation – in particular, on the purchase behavior patterns of the consumers in the sample. Therefore, a manager wanting to analyze micro-marketing strategies for a particular region should estimate his model using consumer purchase data from stores in that region[1].

The above discussions motivate the study in this paper. I investigate the effects of several variables, both product-related and consumer-related, on the purchase quantity decisions of consumers buying in the yogurt category[2]. I adopt a Poisson framework to model purchase quantities and estimate the parameters of the model using a maximum likelihood procedure. The Poisson model is a statistical framework that is typically used to model the distribution of count or discrete data (for which the observations always take on positive integer values). The framework is well suited to modeling the distribution of purchase quantities since it readily captures the idea that goods are always purchased in integer quantities. From my study, I analyze how factors such as the price of the product, whether the product was featured, demographics of the household that purchased the product, and the total amount spent on a purchase occasion affect the consumer's decision to purchase a particular number of units of the product. From basic micro-economic theory, we expect to see that a change in price inversely affects the quantity demanded, and that changes in promotions positively affect demand. We also expect to see that larger and higher income families and those that spend more on shopping trips buy more units on average. The results from the analysis bear out these facts. I also quantify the effect of each of these factors on the quantity purchased.

The rest of the paper is structured as follows: In the next section, I present the methodology for the formulation and estimation of the Poisson model. In the subsequent section, I describe the data, and provide descriptive statistics of the variables used in the study. In section 4, I present the results and discuss their implications. Section 5 concludes the paper and identifies avenues for future research.

Model development and Methodology

I adopt a Poisson model framework for the statistical analysis. I present a brief overview of the Poisson model in the next subsection, and then present the purchase quantity model and the estimation technique in section 2.2.

2.1 Poisson model framework

The Poisson model is a popular framework that is well suited to model the distribution of count data or discrete data, in which the dependent variable takes on only non-negative integer values. The framework is attractive for modeling purchase quantities since the number of units purchased by consumers, the dependent variable of interest, is always a non-negative integer. A data generating process can be modeled as being Poisson under the assumptions that the number of observed events is proportional to the length of the time interval, and that the occurrence of events in different (non-overlapping) time intervals are independent of one another (Berry and Lindgren 144)[3]. The following discussion explains how this definition of a Poisson model is applicable to the purchase quantity model.

With frequently purchased goods, for example yogurt, it is reasonable to believe that the number of units purchased by the consumer is directly proportional to the length of the inter-purchase time (the time since the last purchase of the product). This might be because the units purchased in the last occasion are consumed systematically over time across various consumption occasions, leading to the purchase of more units on the next trip to restock depleted household inventories. Again, it is reasonable to believe that most families have a fixed demand for yogurt – say five units per week. Therefore, a higher than usual purchased number of units in a given week, for instance, could occur typically because the price was low or because the product was on promotion. Assuming prices and promotions are independent across time-periods, the number of units purchased by a given family in a particular time-period would be independent of the number of units purchased in the last time-period. Under these conditions, we can think of the data generating process for purchase quantities as being Poisson. With access to data on the quantities of a good purchased by various consumers across various purchase occasions, we can empirically estimate the parameters of the Poisson model. This is the strategy adopted in this paper. The formulation and estimation of this model is presented in the next subsection.

2.2 Model formulation and estimation

Formally, if a random variable Y has a Poisson distribution, the probability that it takes on a value y is given by

$$P(Y = y) = \frac{e^{-\lambda}\,\lambda^{y}}{y!}$$

where λ is a parameter of the Poisson model. We consider a simple random sample with m observations on the quantities purchased by consumers of a particular good[4]. Let q_i represent the quantity purchased by consumer i in the sample $i = 1,\ldots,m$ and let X_i represent a 1 by k (1 X k) vector of characteristics associated with consumer i on the purchase occasion. X_i can include the price and promotions of the product at the time of purchase along with demographic variables of consumer i. Denote the Poisson parameter associated with consumer i by λ_i. By assumption, the quantity purchased by consumer i, that is q_i, is a realization of the Poisson process with parameter λ_i. Therefore, the probability that quantity $Q_i = q_i$, $P(Q_i = q_i)$, is given by:

$$P(Q_i = q_i) = \frac{e^{-\lambda_i}\,\lambda_i^{q_i}}{q_i!}$$

the good. We only want to model how many units of the good consumer i has purchased, given that he or she purchases some positive number of units on that trip (i.e., given that $Q_i > 0$). Thus, we want to obtain an expression for the probability that quantity $Q_i = q_i$, given the event that $Q_i > 0$. In the data, we will restrict attention to those purchase occasions for which a non-zero number of units were bought. Then, for each observation in the data, the probability of observing q_i number of units being purchased is $P(Q_i = q_i \mid Q_i > 0)$. Therefore, we first need to derive a formula for $P(Q_i = q_i \mid Q_i > 0)$ given our assumption that Q is Poisson. Now, for the Poisson distribution, we know that

$$P(Q_i > 0) = 1 - P(Q_i = 0) = 1 - \frac{e^{-\lambda_i}\lambda_i^{0}}{0!} = 1 - e^{-\lambda_i}$$

From the rules of conditional probability, the probability of an event *A* given another event *B* can be evaluated as the probability of both events *A* and *B* occurring, divided by the probability of event *B* occurring. Mathematically,

$$P(A|B) = \frac{P(AB)}{P(B)}.$$

Here, *A* is the event that $Q_i = q_i$ and *B* is the event that $Q_i > 0$. The event *AB*, that is the event that both *A* and *B* occur, is simply the event *A* itself (since if $Q_i = q_i$ [event *A*], it must be that $Q_i > 0$ [event *B*]). Therefore,

$$P(Q_i = q_i | Q_i > 0) = \frac{P(Q_i = q_i)}{P(Q_i > 0)} = \frac{e^{-\lambda_i}\lambda_i^{q_i}}{(1 - e^{-\lambda_i})}$$

$i = 1,\ldots,m.$

The likelihood of the sample is the joint probability of the data given the parameters λ_i, $i = 1,\ldots,m$. Since the observations are considered to be independent of each other, the likelihood of the sample is the product of the Poisson probabilities across all the observations. That is, the likelihood of the sample is:

$$L = \prod_{i=1}^{m} P(Q_i = q_i | Q_i > 0) = \prod_{i=1}^{m} \frac{e^{-\lambda_i}\lambda_i^{q_i}}{(1 - e^{-\lambda_i})}$$

The technique that we adopt for estimation of the Poisson model, maximum likelihood estimation, is based on the principle that the parameters that explain the data the "best" are the ones that maximize the likelihood function *L* above. We now note that the set of parameters that maximize the likelihood *L* is the same as the set of parameters that would maximize the logarithm of the likelihood function. Working with the logarithm of the likelihood function is easier since it converts the product of *m* terms in *L* above, to the sum of *m* terms. The log-likelihood of the sample can be obtained by simply taking logarithms on both sides of the above equation. Thus we get:

$$\begin{aligned}\log(L) &= \sum_{i=1}^{m} \log\left(\frac{e^{-\lambda_i}\lambda^{q_i}}{(1-e^{-\lambda_i})q_i!}\right) \\ &= \sum_{i=1}^{m}\left[\log(e^{-\lambda_i}) - \log(1-e^{-\lambda_i}) + \log(\lambda_i^{q_i}) - \log(q_i!)\right] \\ &= \sum_{i=1}^{m}\left[-\lambda_i - \log(1-e^{-\lambda_i}) + q_i\log(\lambda_i) - \log(q_i!)\right]\end{aligned}$$

To summarize, at this point we have obtained an expression for the log-likelihood of our sample of observations of purchase quantities in terms of the parameters λ_i, $i = 1,\ldots,m$. λ_i, the mean of the Poisson process, is related in some way to the prices, promotions and demographics of consumer *i* on that purchase occasion. One way to capture this is to *assume* that the way in which λ_i depends on these variables is:

$$\lambda_i = X_i * \beta$$

where β is a *k* by 1 (*k* X 1) vector of parameters. Nevertheless in estimation, we would like to restrict λ_i to be positive, since only positive λ_i are consistent with the Poisson distribution. A convenient parameterization that achieves this that I adopt is

$$\lambda_i = \exp(X_i * \beta).$$

Thus, provided we know the vector â we can calculate λ_i for each individual *i* in our sample. Then, to evaluate the log-likelyhood of the sample, all we have to do is evaluate

$$-\lambda_i - \log(1-e^{-\lambda_i}) + q_i\log(\lambda_i) - \log(q_i!)$$

for each individual *i* in the sample, and then sum this value across all $i = 1,..,m$. The set of parameters β that explain that explain the data the "best" can now be found by finding the parameter vector that maximizes this log-likelyhood function. I estimate the vector β by programming the log-likelyhood function in MATLAB® and numerically searching for the maximum.

3. Data

The data that I use are scanner-panel data collected by the A.C. Nielsen Company and made freely available by the company to the academic community at the Kilts Center for Marketing at the University of Chicago[5]. The data are called the ERIM scanner-database data and were collected by the now-defunct ERIM division of the A.C. Nielsen Company on panels of households in two mid-sized Midwestern cities. The scanner data of the sort used in this paper have set off a new revolution in the marketing area, enabling the disaggregate and detailed modeling of the various aspects of consumer purchase behavior mentioned in the introduction. The use of the data is a relatively new phenomenon, since the technical capabilities for data collection at this scale and level of detail were acquired by companies only in the last decade.

The scanner panels work as follows: households are first recruited to the panel and are paid to record their grocery purchases by scanning the bar codes on individual items purchased using in-home bar code scanners[6] provided to them by the company. This information is transmitted to a centralized database via the phone line or a modem. The company thus has a comprehensive database of the purchases made by all members of the panel over an extended period of time. Major stores in the area are also linked to the central database, so that brand-level sales and prices, promotions and other store-environment information is also available – which can be related to the purchases made by the panel members. In addition, household demographic information is also collected. The panels are also demographically balanced to represent the household population of the mainland United States. To summarize, the panels can be regarded as a good source for understanding consumer purchase behavior and shopping patterns for all segments of the population[7].

The ERIM scanner-data that I use were collected for a panel of households in Sioux Falls, South Dakota. The population from which this sample is drawn is thus the set of all households in Sioux Falls. According to A.C. Nielsen, the demographic profile of Sioux Falls is very similar to the demographic profile of the U.S. as a whole, and therefore, the city could be considered a good representation of the U.S. population.

Within the panel, I restrict attention to only the yogurt category. Being drawn from a panel, the raw data contained repeated observations on each household's purchase quantity decisions of yogurt. Since I wanted to avoid the complexities of analyzing a panel dataset, I drew a random sample from the base database, to develop a cross-sectional sample – that is, a sample drawn from the population at a single point in time. To do this, I first randomly picked a sample of 2367 households from the available panel of households (using a random number generator within the SPSS statistical software). The panel dataset contained purchase history data corresponding to various purchase occasions for each of those 2367 households. I then randomly selected a single purchase occasion, for each of the 2367 households that I picked previously, thus resulting in a dataset of 2367 observations that can be considered cross-sectional. This is the dataset that I used in my estimation. To summarize, at this stage, I had at my disposal a dataset of 2367 observations that correspond to a simple random sample of various households' purchases of yogurt. The data contained the following information:

Dependent variable:

- *Purchased quantity, Q* (number of 6oz. containers of yogurt purchased)

Independent Variables:

- *Price* (in $ per ounce)
- *Feature* (categorical 0/1 variable indicating whether the product was featured in local advertisements – typically, free standing inserts in newspapers in that week)
- *Expenditure* on that particular trip or purchase occasion (in $$)
- Household Income (in scales of 1-14 for 1000-s of $$), *HHinc*
- Household size, *HHsize*
- Number of days since the last purchase of yogurt (i.e. inter-purchase time), *IPT.*

Figure 1 shows the empirical distribution of quan-

tity of yogurt across the 2367 household trips during which an item was purchased in this category. As can be seen, most households purchase around two units of yogurt on a particular purchase occasion, though the maximum number could be as high as nine in some cases, perhaps due to very low prices in those weeks. We see that the distribution of quantities is strongly skewed to the right, indicating that a naive linear regression of quantities on the independent variables would be inappropriate.

Table 1 presents descriptive statistics of these variables. As can be seen, there is considerable variation in prices and in the demographic variables.

4. Results

In this section, I present point estimates for each of the parameters, and test their significance. The parameter estimates are presented in Table 2. These estimates correspond to the Poisson model with

$$\lambda_i = e^{\beta_0 + \beta_1 * price_i + \beta_2 * feature_i + \beta_3 * Expenditure_i + \beta_4 * HHinc_i + \beta_5 * HHsize_i + \beta_6}$$

The model was estimated by maximizing the likelihood function within MATLAB®.

A brief discussion of the results follows.

i) Constant: The constant β_0 does not have any behavioral significance. It simply serves to adjust the model for the range of the data. There is no intuitive explanation for this parameter value.

ii) The coefficient on *Price* is negative and highly significant, consistent with what we expect from basic microeconomic theory – price is an important driver of quantity purchased, and as price increases, the quantity purchased will decrease.

iii) The coefficient on *Feature* is positive but not very significant. This indicates that yogurt being featured in the week of purchase does not have much effect on the purchase decision. The lack of precision might possibly be due to the low variation of *Feature* in the data.

iv) The coefficient on *Expenditure* is positive as expected. The quantity of goods purchased is increasing in the total value spent by each household on a shopping trip.

v) The income of the household has a positive effect on Q*uantity*. This could reflect higher spending power of higher income households, though it is unclear why higher income households would buy more number of units of yogurt compared to lower income households.

vi) Contrary to expectations, the household size has a negative effect on *Quantity*, but this effect is insignificant.

vii) The coefficient on inter-purchase time is positive. This is consistent with the observation that a household would purchase higher number of units of yogurt as the number of days since the last purchase increases. However, this effect is not very significant.

Overall, the results are intuitive and consistent with our apriori expectations. To demonstrate the use of these estimates, in table 3 below, I hold all the exogenous variables except *Price* fixed at their approximate means in the data, and compute λ for different values of *Price*. From the estimated model,

$$\begin{aligned}\lambda_i = \exp\,(&0.6458 - 3.0941 * \text{price}_i + 0.2262 * \text{feature}_i \\ &+ 0.0056 * \text{Expenditure}_i + 0.0353 * \text{HHinc}_i \\ &- 0.0556 * \text{HHsize}_i + 0.0069 * \text{IPT}_i)\end{aligned}$$

For each value of λ, I also compute the probability of purchase, $\Pr(Q > 0) = 1 - e^{-\lambda}$.

From table 3, we see that both the mean quantity demanded, λ, and the probability of purchase, $\Pr(Q > 0)$, is decreasing in price. Using such an exercise, a sophisticated retailer could conceptually trace out the empirical distribution of the mean quantity and average probability of purchase across possible price and promotion levels for any demographic profile that he or she would consider targeting. These can then form inputs to the formulation of optimal price and promotional policies.

A word of caution about the results: the parameter estimates in table 2, are only relevant for the population under consideration – that is, for the consumers of Sioux Falls, South Dakota. The results cannot be extended to other regions without re-estimating the model using purchase data from those regions too. Additionally, since I do not consider the time-varying aspect of consumer purchase decisions, for accurate prediction of consumer response for a

different time-period during which significant changes in consumer behavior occurred, the model will have to be estimated again using data from those time-periods. This might be the case if economic conditions change drastically. However, for goods like yogurt, which form a small fraction of the shopping budget, this would probably not be a matter of huge concern.

5. Conclusions

In this paper, I have developed a model of the quantity decisions of consumers purchasing a grocery product. My aim in developing this model is to understand and demonstrate how a simple model of purchase quantity can help the marketing manager relate consumer purchase decisions to key marketing-mix variables like prices and promotions. The model was estimated using real-world purchase data on consumer-purchases of a brand of yogurt in an American city. The data, generically called "scanner-data", were collected by the A.C. Nielsen Company and were obtained from the Kilts Center for Marketing at the University of Chicago.

I adopt a Poisson model framework to study the effects of several variables, both product-related and consumer-related, on the purchase quantity decisions of consumers buying yogurt. The Poisson framework is chosen since it is a straightforward framework for studying the effects of the above exogenous variables on the response variable, *Quantity* that takes on strictly integer "count" values. Within this framework, I analyze how factors such as the price of a brand of yogurt, whether the brand was featured, demographics of the household that purchased the brand, and the total amount spent on a purchase occasion affect the consumer's decision to purchase a particular quantity.

Estimated results indicate that price and shopping-trip expenditure are significant variables in explaining the quantity purchased. Extensions to this study could be to accommodate brand-choice as well as quantity-choice decisions of consumers, and also to use panel data instead of cross-sectional data so as to capture individual-specific differences in purchase behavior. Use of more generalized count data models other than the Poisson model can also be explored.

Acknowledgements

I wish to thank Dr. Phillip Kushner, Dept. of Mathematics, University of Texas at Austin, for his guidance and support through the completion of this project. I also thank Harikesh Nair, Graduate School of Business, University of Chicago, for his help with sampling the base dataset that was used for this project and for useful discussions.

Appendix: Graphs & Figures

Table 1 Summary statistics of all variables

	Quantity	Price	Feature	Expenditure	HH Income	HH Size	IPT
Mean	2.54	0.09	0.07	36.82	8.75	2.81	3.97
Std	1.73	0.02	0.26	31.57	3.79	1.17	4.24
Min	1.00	0.01	0.00	3.00	1.00	1.00	1.00
Max	9.00	0.13	1.00	286.72	14.00	6.00	84.00

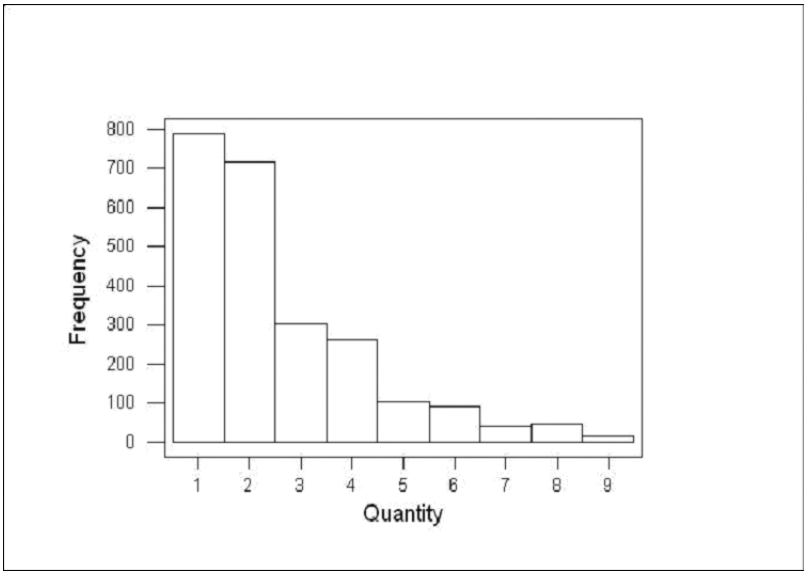
Table 1 Parameter estimates for the Poisson model

Variable Name	Parameter value	t-Statistic[8]
Constant β_0	0.6458	6.3777
Price per Ounce	-3.0941	-12.6905
Feature	0.2262	1.3509
Expenditure	0.0056	25.2810
Household Income	0.0353	3.5914
Household Size	-0.0556	-0.3936
Inter Purchase Time	0.0069	0.3255
Number of observations, m	2367	
Log-likelihood at convergence, log (L)	-4002.2901	

Table 1 An illustration of the model: predicted probability of purchase

Price	Feature	Expenditure	HH Income	HH Size	IPT	λ = Mean Purchase Quantity	Pr (Q > 0) = Probability of Purchase
0.10	0	35.0	8	3	4	1.965192	0.86
0.20	0	35.0	8	3	4	1.442215	0.76
0.30	0	35.0	8	3	4	1.058412	0.65
0.40	0	35.0	8	3	4	0.776747	0.54
0.50	0	35.0	8	3	4	0.570039	0.43
0.60	0	35.0	8	3	4	0.418340	0.34
0.70	0	35.0	8	3	4	0.307012	0.26
0.80	0	35.0	8	3	4	0.225310	0.20
0.90	0	35.0	8	3	4	0.165350	0.15
1.00	0	35.0	8	3	4	0.121347	0.11

Figure 1 Empirical distribution of quantity of yogurt purchased across all household trips



Endnotes

1 This sort of data – called *scanner-data*, are collected by various marketing companies, and are increasingly being used by marketing researchers and practitioners. I will describe the data in section 3.

2 I chose yogurt because data for this category were freely available from the Marketing department at the University of Chicago. (See http://gsbwww.uchicago.edu/kilts/research/db/erim). The analysis developed for this category is applicable to most other frequently purchased grocery categories.

3 One outcome of a data generating process is called an event. In this case, an event would be a particular number of units purchased. The time elapsed since the last purchase of the product, or the inter-purchase time, can be regarded as one time interval.

4 A dataset of size m is said to be a simple random sample when every possible subset of m units in the population has the same chance of being the sample.

5 See http://gsbwww.uchicago.edu/kilts/research/db/erim

6 Hence the name "scanner-panel"

7 For more information on the AC Nielsen panels, go to http://acnielsen.com/products/reports/homescan/

8 The parameters that have a t-statistic ≥ 1.98 can be considered to have a significant effect on the response variable at the 95% significance level.

References

Berry, Donald A. and Lindgren, Bernard W. *Statistics: Theory and Methods.* Duxbury Press, 1996.

Leeflang, Peter S.H. and Wittink, Dick R. et al. *Building Models for Marketing Decisions,* International Series in Quantitative Marketing, Vol 9. Kluwer Academic Publishers, 2000.

Van Loan, Charles F. *Introduction to Scientific Computing: A Matrix vector Approach using MATLAB®.* Prentice Hall, 1999.

Treatment and Outcome in Patients with Adenoid Cystic Carcinoma of the Base of Tongue

The University of Texas at Austin

Undergraduate Research Journal

Volume 2
Spring 2003

Amy Chen, *The University of Texas at Austin*

Rarely encountered in humankind, salivary gland cancers represent a diverse group of tumors exhibiting a wide range of biological behavior. The American Cancer Society estimates their incidence to be between 1 and 2 per 100,000 of population (Anderson). Whereas the major salivary glands consist of the parotid, submandibular, and sublingual glands, the minor salivary glands consist of 600 to 1000 small glands distributed in the mucus membrane of the upper aerodigestive tract. Numerous studies have concluded the parotid as the most common site of salivary gland tumors. The most prevalent types of salivary gland carcinomas include adenocarcinoma, adenoid cystic carcinoma, mucoepidermoid, acinic cell carcinoma, squamous cell carcinoma, and ex-pleomorphic adenoma. Adenoid cystic carcinoma (ACC) is a rare, epithelial malignant tumor that represents about 7% of all head and neck tumors and accounts

for 10% of all salivary gland tumors (Fordice, Gates). ACC is the most widespread, malignant tumor of the minor salivary gland, where it most frequently occurs in the palate, the roof of the mouth (Buchholz).

Aggressive, yet indolent in nature, ACC is often characterized to diffuse slowly into surrounding tissue at a doubling rate of 1.5 to 18 months. Thus, the delayed responses and impact on survival result in an intricate process for assessment and interpretation. ACC has a high local recurrence rate and a high tendency of distant metastasis, the spread of cancer to areas distant from the originating site of cancer, especially to the lung, brain, and bone. However, due to the rarity of this disease, little has been written concerning the factors that influence distant spread and subsequent survival. More than a decade of observation may be required to appreciate the entire clinical course in most patients. Its prolonged clinical course and tendency of delayed onset of distant metastasis increase the complexity of treating this disease. ACC has a predilection for invasion of the adjacent stroma and neural tissue, following the roots of cranial nerves that surround the neoplasm.

Adenoid cystic carcinoma is a firm tumor that may have well-or poorly defined margins. Those with well-defined margins often show areas of infiltration. The hard cut surface is white, gray, or pink, and, despite the name adenoid cystic, shows little or no cyst formation. Microscopically, the tumor has uniform cells, with small, dark nuclei (Norberg-Spaak, Wenig). Cell borders are indistinct while mitoses are rare. There are three main types of ACC. Cribriform, the most common type, is composed of small polygonal cells with basophilic cytoplasm, creating many oval, circular spaces. It is often noted for its "Swiss Cheese" configuration. The tubular type has cells arranged in ducts or tubules and contains mucinous material. Cells in the solid type are arranged in sheets or nests of varying size or shape.

Adenoid cystic tumors in the base of the tongue is a diagnostic and therapeutic challenge because of the subtle presenting symptoms, slow growth of this tumor, unusual submucosal location, and the difficulty in examination of the pharyngeal tongue (Roper). Therefore, many patients receive a delayed diagnosis. Common initial complaints of ACC in the base of the tongue include dysphagia, oltalgia, hoarseness, speech difficulty, sore throat, tongue immobility, a mass in the throat, and airway obstruction. Symptoms vary according to the location of the lesion on the tongue.

Wide local surgical removal of the primary tumor is crucial in preventing future tumor recurrence due to this disease's tendency of extremely diffuse invasion. Many patients also receive postoperative radiation to complete their treatment. The combination of surgery and postoperative radiation therapy improves locoregional control of the disease (Fordice). However, the usefulness of radiotherapy for patients with ACC is still controversial (Umeda).

Effective treatment modalities and accurate survival statistics have been difficult to obtain because of the lack of information and studies conducted on adenoid cystic carcinoma in the base of the tongue. The present study was done to assess the outcomes of the different therapies applied, along with the survival rates, types of recurrences, and survival factors.

Materials and Methods

A retrospective review of 38 medical records from 1962 to 1997 was conducted on all patients treated for adenoid cystic carcinoma in the base of tongue who were registered at The University of Texas M.D. Anderson Cancer Center. Patient population was identified through a search of database maintained by Dept. of Medical Informatics.

A comprehensive chart review of all patients was done to obtain specific information. The patients' presenting symptoms, risks factors (tobacco or alcohol use), other known malignancies, and sites of primaries were carefully recorded. The review also searched for tumor stage according to the American Joint Committee, biopsy date and type, the presence of perineural invasion, incorrect outside diagnosis, and positive margins. The date, role, and type of surgery and or radiation were also recorded from each patient.

The response to radiation and the patients' physical complaints during the therapy were noted. The quality of life after treatment was studied, including each

patient's diet, speech, and use of G-tube. Any local or regional recurrences and distant metastases were recorded along with the date of the recurrence(s), type of salvage treatment, and response to treatment. Information gathered pertaining to the outcome of each patient includes the date of last clinic visit at M.D. Anderson, the date of last contact, the status at last contact, and the survival time.

This clinical study was reviewed and administratively approved by the Institutional Review Board to evaluate the presentation, therapeutic approach, and outcome of patients with adenoid cystic carcinoma in the base of the tongue.

Results

Five patients were seen only in consultation, and were excluded from further study. Thus, data on 33 patients was available for analysis of treatment and outcome.

The cohort included 13 males and 20 females, ranging in age from 29 to 85 years, with the average age at diagnosis being 57 years. Race distribution showed 72.7% were White, 12.1 % were African American, 15.2% were Hispanic, and 0% was Asian. The length of follow-up period ranged from 25 months to 253.9 months, with an average of 98.7 months (8.2 years).

Treatment modalities included sole surgical resection, sole standard or neutron radiation therapy, combined surgery and radiation therapy, or other (chemotherapy or tamoxifen). The distribution of patients according to primary therapy is shown in Figure 1.

The mean total dose of radiation in those patients receiving radiation was 52.2 Gy, with a rage of 20.4 Gy to 68.0 Gy.

Survival

The 5 and 10-year overall survival rates were 71.7% and 41.1%, respectively. The 5 and 10-year disease-specific survival rates were 83.1% and 77.5%, respectively.

The 5-year survival rate for males, 83.3%, was slightly higher than females, who had a 5-year survival rate of 73.7%. There was a 81.0% 5-year survival rate in patients younger than 60 years of age and a 70.0% 5-year survival rate in patients older than 60. 83.3% Whites had a 5-year survival rate, while African Americans and Hispanics had 66.7% and 50.0% 5-year survival rates, respectively.

All of the presenting symptoms, excluding tongue mass and neck mass, had no significant effect on the survival rate of patients. Patients with a tongue mass at the time of presentation had a 60% 5-year survival rate whereas patients who did not present with a tongue mass had an 80% 5-year survival rate. There was a 75% 5-year survival rate in patients who did not present with a neck mass and only a 50% 5-year survival rate in patients who did present with a tongue mass. Perineural invasion, the presence of other malignancies, and history of tobacco or alcohol use did not influence survival. Patients with impaired tongue mobility before treatment had a 5-year survival rate of 50.0% whereas patients who did not present with impaired tongue mobility had a 5-year survival rate of 77.8%. The T Stage data (Figure 5) shows that the higher the stage of the tumor, the lower the survival rate.

From the data obtained, the T Stage at presentation did not influence survival rates. Patients who received incorrect outside diagnosis had a 57.1% 5-year survival rate. However, patients who did not have incorrect outside diagnosis had an 82.6% 5-year survival rate.

Patients who had any type of surgery generally had a longer survival rate (84.2% 5-year survival rate) than those who did not have surgery (66.7% 5-year survival rate). The 5-year survival rate for patients who had glossectomy or laryngectomy increased by 14.1% and 23.3%, respectively. Patients who received radiation treatment increased their 5-year survival rate by 26.2%. There was no correlation between neutron treatment and survival rates. However, patients who had surgery alone or radiation alone had 10-20% lower 5-year survival rates. Patients treated with both surgery and radiation had a 5-year survival rate of 92.9% as compared to 64.7% in those who did not have both treatments.

The 5 patients who were diagnosed with only local recurrence lived an average of 84.5 months (7.0 years) with a range of 3 to 231 months. The 19 patients who were

diagnosed with distant metastases survived an av-erage of 34.3 months (range of 2-120 months).

Recurrence

Recurrence statistics were not as favorable as survival outcomes. 26 of the 33 (76.5%) patients had any type of recurrence after treatment. The distribution of the different types of recurrences by treatment category is shown in Table 1.

This table shows that the patients who were treated with standard radiation had the highest local recurrence rate and patients treated with neutron radiation had the highest distant metastases rates. Patients who received surgery or surgery + XRT had the lowest local recurrence and distant metastases rates, respectively.

Figure 4 indicates that patients who were treated with surgery only recurred the quickest after treatment whereas patients who received standard radiation only developed recurrence the slowest.

The most common location of the primary was the left side of the tongue (63.6% of the patients), while 36.4% of the patients presented with right primaries, and 3.0% with midline primaries.

The most frequent symptom was dysphagia, which was reported by 50% of the patients. 44.1% of the patients suffered from otalgia, 32.4% suffered from speech difficulty, and 26.5% suffered from sore throat. Few patients presented with tongue mass, neck mass, globus sensation, or oral bleeding.

Five of the thirty-four patients presented with other malignancies at the time of diagnosis. Two of those patients had breast malignancies, one had adenocarcinoma in the lung, one had a rectal tumor, and one had squamous cell carcinoma in the lung.

After treatment, 28.6% (4/14) of the patients were on a regular diet, 64.3% (9/14) were on a pureed, soft diet, and 7.1% (1/14) were on a liquid diet. 20 of the 34 patients reviewed were not recorded regarding their diet after treatment.

50% (8/16) of the patients recorded communicated orally after their treatment, 43.8% (7/16) communicated with artificial aids, and 6.2% (1/16) communicated by writing only. 18 patients were not recorded concerning their speech after treatment.

Two of the sixteen patients recorded were G-tube dependent for only 6-12 months after receiving therapy. One of these patients underwent both surgery (glossectomy and laryngectomy) and XRT. The other patient was treated only with radiation. Fourteen of the sixteen became G-tube dependent for more than one year. Eight of these had both surgery and radiation therapies, three of these were treated only with surgery, and another three were treated only with radiation.

Discussion

From Table 1, surgery improved patients' locoregional control while patients treated with standard radiation had the highest local recurrence rate. The rate of distant metastases was highest in patients treated with neutron therapy. This data questions the effectiveness of neutron radiation. Patients treated with combined surgery and radiation had improved distant metastases rates.

According to figures 2 and 3, patients treated solely with radiotherapy lived the longest while patients treated solely with surgery lived the shortest amount of time after their treatment. From this, we can conclude that treating a patient with surgery only is no the best method. The "Surgery only" curve exhibited by far the lowest survival rate in both figures 2 and 3, while the "Radiotherapy" and "Surgery & Radiotherapy" curves were quite close in numbers. However, the accuracy of the "Radiotherapy" and "Surgery & Radiotherapy" curves is questionable due to the low number of patients evaluated.

The overall survival of patients in Figure 3 indicates a shorter life span for patients because it accounts for any factor that may have caused a patient's death whereas the disease-specific survival of patients in Figure 2 evaluates the survival rate of patients who died of the disease only.

From Figure 4, patients who did not receive any radiation most likely recurred sooner due to adenoid cystic carcinoma's common nature of perineural invasion. Radiation inhibits perineural invasion in most cases while surgery does not.

Because patients who were treated with both surgery and radiation had a 5-year survival rate of 92.9% as

compared to 64.7% in those who did not have both treatments, we conclude that combined surgery and radiation therapy result in the highest 5-year survival rate. This is presumably because surgical resection reduces locoregional recurrence and postoperative radiation reduces metastasis and perineural invasion, thus increasing the patient's survival rate.

The amount of patients who were G-tube dependent, did not have a regular diet, and communicated with artificial aids after treatment indicates a poor quality of life after treatment.

The lower survival rate of patients who received incorrect outside diagnosis may be attributed to delayed treatment. Although only a few patients were analyzed, it is possible to note that the earlier the correct diagnosis, the longer the patients survive.

Conclusion

This study showed that patients treated with radiation, particularly combined surgery and radiation, had improved locoregional control and disease-specific survival rates.

Long-term survival rates were reasonably good. The disease-specific survival rates were 83.1% and 77.5% at 5 and 10 years, respectively. Long-term survival was also possible after local recurrence or distant metastases.

Since the distant metastases rate was highest for patients treated with neutron radiation, there was no improved outcome detected with neutron radiation as compared to standard radiation.

The data recorded on the quality of life of patients after treatment shows that morbidity of treatment is significant.

However, this study may not be statistically accurate because of the few number of patients evaluated. Because there have only been 38 patients treated for adenoid cystic carcinoma of the base of tongue at such a large cancer institution, UTMDACC, within a period of 36 years, it can be concluded that ACC of the base of tongue is a very rare yet malignant disease.

Appendix: Graphs & Figures

Table 1 Types of Recurrences by Different Treatment Methods

	Surgery Only	XRT Only	Standard XRT	Neutron	Surgery + XRT
Local Recurrence	0/5, 0%	2/10, 20%	1/4, 25%	1/6, 16.7%	3/17, 17.6%
Regional Recurrence	1/5, 20%	0/10, 0%	0/4, 0%	0/6, 0%	0/17, 0%
Distant Metastases	4/5, 80%	7/10, 70%	2/4, 50%	5/6, 83.3%	8/17, 47.1%
Any Recurrence	5/5, 100%	9/10, 90%	3/4, 75%	6/6, 100%	11/17, 64.7%

Figure 1 Distribution by Therapeutic Modality

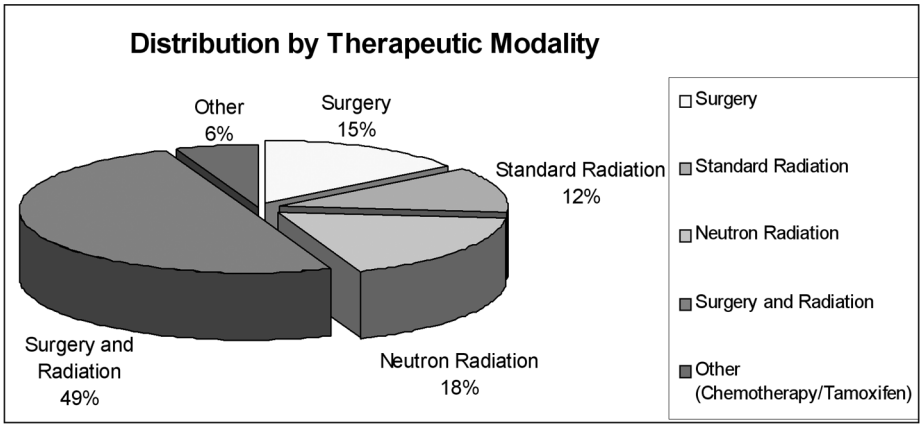


Figure 2 Overall Survival of Patients with Adenoid Cystic Carcinoma of the Base of Tongue: Effect of Treatment Modality

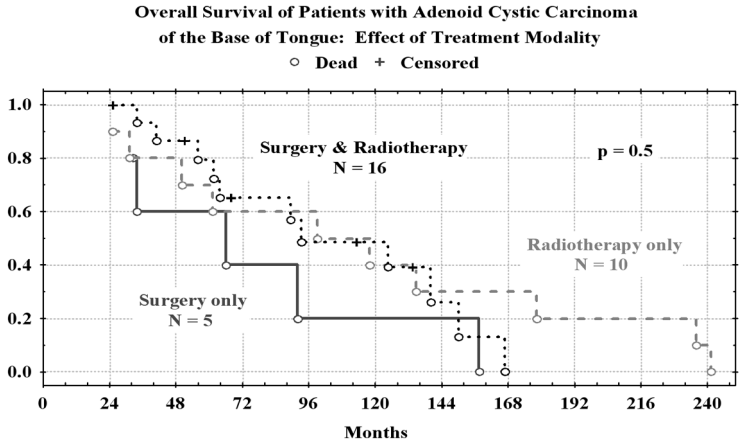


Figure 3 Disease-Specific Survival of Patients with Adenoid Cystic Carcinoma of the Base of Tongue: Effect of Treatment Modality

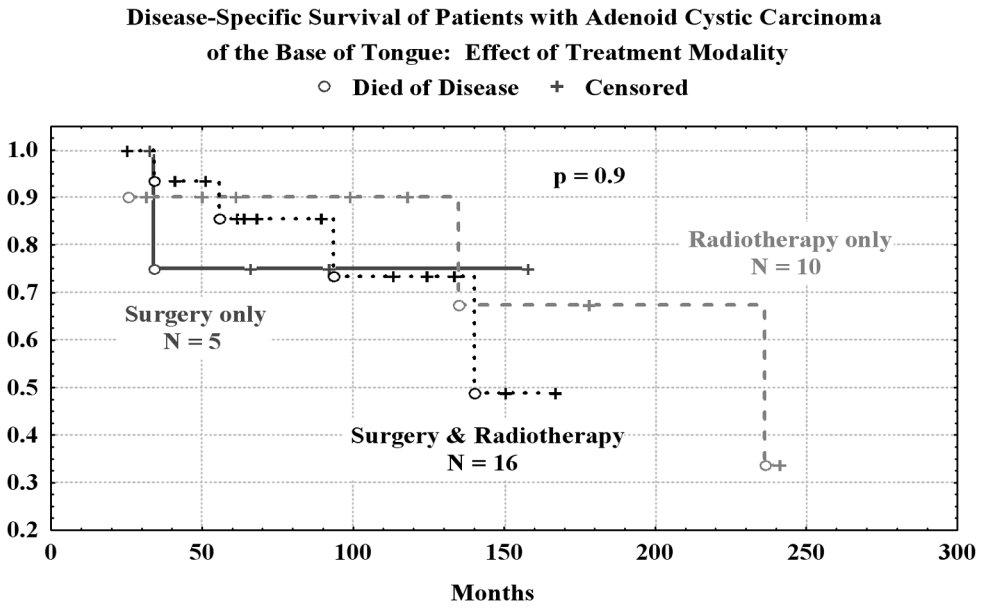
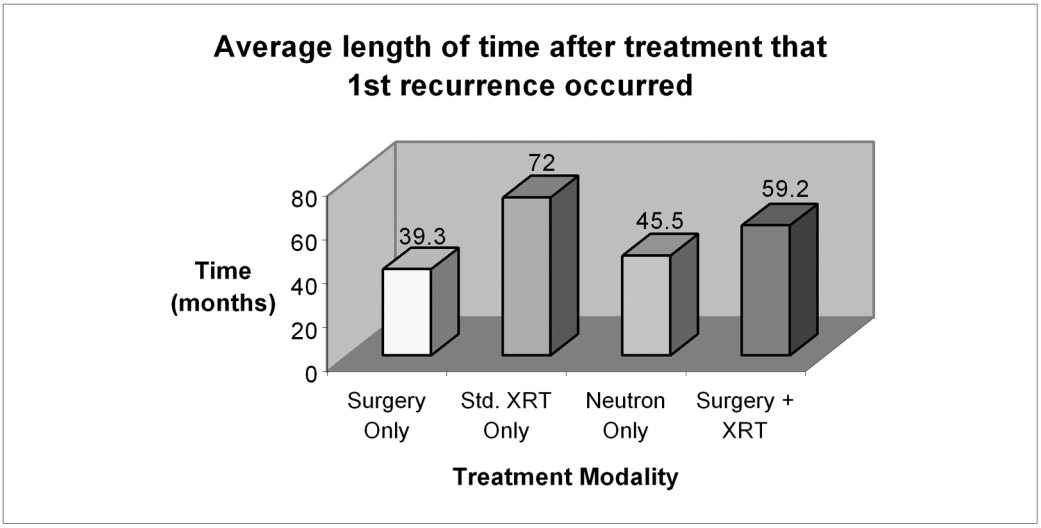
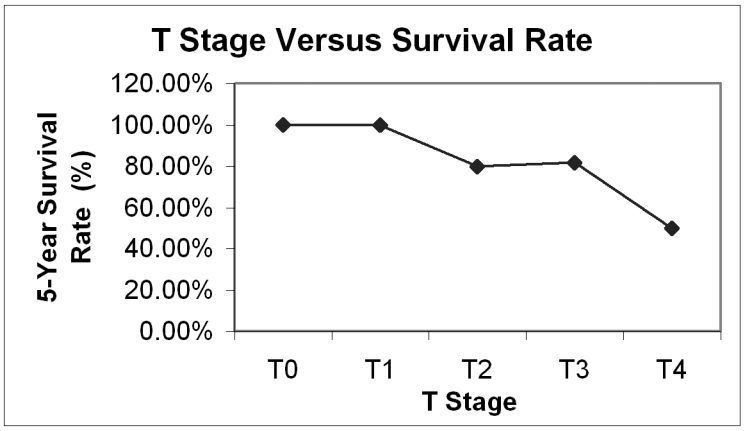


Figure 4 Average Length of Time After Treatment that 1st Recurrence Occured



Appendix: Graphs & Figures

Figure 5 | T Stage Versus Survival Rate



References

Anderson JN, Beenken SW, Crowe R, Soong S-j, Peters G, Maddox WA, Urist MM. Prognostic Factors In Minor Salivary Gland Cancer. *Head & Neck* 17:480-486, 1995.

Avery CME, Moody AB, McKinna FE, et al. Combined Treatment of Adenoid Cystic Carcinoma of the Salivary Glands. *International Journal of Oral & Maxillofacial Surgery* 29:277-279, 2000.

Buchholz TA, Shimotakahara SG, Weymuller EA, Laramore GE, Griffin TW. Neutron Radiotherapy for Adenoid Cystic Carcinoma of the Head and Neck. *Archives of Otolaryngology-Head & Neck Surgery* 119:747-752, 1993.

Douglas JG, Laramore GE, Austin-Seymour MM, Koh W-j, Stelzer K, Griffin TW. Treatment of Locally Advanced Adenoid Cystic Carcinoma of the Head and Neck With Neutron Radiotherapy. *International Journal of Radiation Oncology Biology Physics* 46:551-557, 2000.

Fordice J, Kershaw C, El-NaggarA, Goepfert H. Adenoid Cystic Carcinoma of the Head and Neck: Predictors of Morbidity and Mortality. *Archives of Otolaryngology- Head & Neck Surgery* 125:149-152, 1999.

Gates GA. Minor salivary gland tumors of the oral cavity. *Otolaryngol Clin N Am* 5:283-289, 1972.

Norberg-Spaak L, Dardic I, Ledin T. Adenoid Cystic Carcinoma: Use of Cell Proliferation, BCL-2 Expression, Histologic Grade, and Clinical Stage as Predictors of Clinical Outcome. *Head & Neck* 22:489-497, 2000.

Prott F-j, Micke O, Haverkamp U, Willich N, Schuller P, Potter R. Results of Fast Neutron Therapy of Adenoid Cystic Carcinoma of the Salivary Glands. *Anticancer Research* 20:3743-3750, 2000.

Roper PR, Wolf PF, Luna MA, Goepfert H. Malignant Salivary Gland Tumors of the Base of the Tongue. *Southern Medical Journal* 80:605-608, 1987.

Umeda M, Nishimatsu N, Hiroshi M, Yoshiki I, et al. Tumor-Doubling Time and Onset of Pulmonary Metastasis from Adenoid Cystic Carcinoma of the Salivary Gland. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology & Endodontics* 88:473-478, 1999.

Umeda M, Nishimatsu, N, Satoshi, Y, Shibuya Y, et al. The Role of Radiotherapy for Patients With Adenoid Cystic Carcinoma of the Salivary Gland. *Oral Surgery, Oral Medicine, Oral Pathology, Oral Radiology & Endodontics* 89:724-729, 2000.

Wenig BM: *Atlas of Head and Neck Pathology*. Philadelphia, W.B. Saunders Co, 1993, pp311-314.

UNIVERSITY CO-OPERATIVE SOCIETY

UNIVERSITY OF TEXAS AT AUSTIN

Undergraduate Research Fellowships

Up to $1000.00!!

Application forms are available from:

(1) The Office of the Vice President for Research
Main Building, Suite 302, 471-2877

(2) The Office of Student Government
SSB 4.206, 471-3166

(3) The UT Austin Research Web Page
www.utexas.edu/research/vp/awards/index.html

The University Cooperative Society has provided a generous gift for the Undergraduate Research Fellowship Program. The Co-op gift is combined with contributions from the Student Government Office and from the Office of the President, as well as contributions from University colleges and schools, to offer University-wide funding for undergraduates.

Purpose: The purpose of this fellowship is to provide support for specific scholarly research projects conducted by UT undergraduate students. These fellowships are intended to cover costs associated with academic research projects proposed and written by student applicants and undertaken with the supervision of a University tenured or tenure-track faculty member, Lecturer, Senior Lecturer, or full-time Research Scientist/Engineer. The supervisor will approve and attest to the appropriateness of the student's research expenses and will be accountable for funds spent.

Eligibility: Any full-time student currently enrolled in a bachelor's degree program in any college of The University of Texas at Austin, or in the PharmD program, may apply for a fellowship. The student must be a full-time student during the fellowship period. Students who already possess a bachelor's degree are not eligible. Only one Undergraduate Research Fellowship (URF) per academic year (September 1 — August 31) may be awarded. Any previous URF award must be completed prior to submission of an award application.

Due date for applications are stated on the form and are generally in mid- to late-September of each year; awards are announced 2-3 weeks after the due date. Check the website for exact dates. Awards will expire August 31 of the year in which they are awarded, unless the student graduates earlier, in which case the fellowship will expire on the date of graduation. Any funds not spent by the expiration date will revert to the URF fund. Funds must be spent in full accordance with University regulations and are subject to the same restrictions as imposed on the use of other State funds.